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Vol. XXIII

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ANNALS

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CARNEGIE MUSEUM

Vol. XXIII

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TABLE OF CONTENTS

Title Page.

Table of Contents.. iii

List of Plates.. v

List of Figures in Text.. ix

List of Genera and Species new to Science.............................. xi

Errata.. xii

1. The Birds of Churchill, Manitoba. By Percy A. Taverner and George Miksch Sutton...................... 1–83

2. The Life History of the Rufescent Woodchuck, *Marmota monax rufescens* Howell. By W. J. Hamilton, Jr...... 85–178

3. The Gerrinæ of the Western Hemisphere (Hemiptera). By C. J. Drake and H. M. Harris...................179–240

4. A Systematic Study of a Collection of Mammals from Southern Arizona. By J. Kenneth Doutt............241–274

5. A Miocene Microfauna and Flora from the Atrato River, Colombia, South America. By I. P. Tolmachoff......275–356

6. The Tertiary Formations of the Uinta Basin, Utah. By J. LeRoy Kay.................................357–371

7. List of Species and Description of New Material from the Duchesne River Oligocene, Uinta Basin, Utah. By O. A. Peterson...................................373–389

8. New Duchesne River Rodents and a Preliminary Survey of the Adjidaumidæ. By J. J. Burke................391–398

9. Mytonolagus, a New Leporine Genus from the Uinta Eocene Series in Utah. By J. J. Burke.............399–420

Index...421-432

LIST OF PLATES

I. Hudsonian Curlew and downy young (Colored).

II. Fig. 1, Spruce Forest and Muskeg Pool near Mosquito Point: Fig. 2, Lake Rosabelle and adjoining tundra lakes, showing characteristic Shore Lines.

III. Fig. 1, Nest and young of Arctic Loon; Fig. 2, Downy young of Arctic Loon removed from nest.

IV. Fig. 1, Nest of Pintail, June 14, 1931; Fig. 2, Old-Squaw on nest, July 4, 1933.

V. Fig, 1, Willow Ptarmigan in changing plumage, May 30, 1931; Fig. 2, Rock Ptarmigan in winter plumage, May 30, 1931.

VI. Fig. 1, Semipalmated Plover; Fig. 2, Golden Plover and downy young.

VII. Fig. 1, Nest of Hudsonian Curlew, June 23, 1931; Fig. 2, White-rumped Sandpipers.

VIII. Fig. 1, Stilt Sandpiper on nest, June 19, 1933; Fig. 2, Nest of Stilt Sandpiper, June 21, 1931.

IX. Fig. 1, Semipalmated Sandpiper on nest, June 30, 1933; Fig. 2, A pair of Northern Phalaropes (female above).

X. Bonaparte's Gull scolding from top of Spruce near nest.

XI. Fig. 1, Nest and eggs of Bonaparte's Gull, June 22, 1933; Fig. 2, Nest, egg, and young of Bonaparte's Gull, July 11, 1931.

XII. Fig. 1, Young Arctic Horned Owl, June 8, 1933; Fig. 2, Hoyt's Horned Lark on nest, June 21, 1931.

XIII. Fig. 1, Hoary Redpoll on nest, June 22, 1931; Fig. 2, Smith's Longspur at nest, July 9, 1931.

XIV. Sketch map of Port Churchill.

XV. Fig. 1, Young Woodchucks twelve hours after birth; Fig. 2, Young Woodchucks one week old; Fig. 3, Young Woodchucks two weeks old.

XVI. Fig. 1, Young Woodchucks three weeks old; Fig. 2, Young Woodchuck four weeks old; Fig. 3, Young Woodchucks five weeks old.

XVII. Fig. 1, Young Woodchucks seven weeks old; Fig. 2, Young Woodchucks eight weeks old; Fig. 3, Rearing cages for Woodchucks. The nest chamber and pipe "burrow" are covered with straw when in use.

XVIII. Fig. 1, Tracks of running woodchuck in snow; Fig. 2, Woodchuck hole in snow; Fig. 3, Woodchuck hole. Note step or platform used for lookout station.

XIX. Fig. 1, Woodchuck Habitat; Fig. 2, Woodchuck Habitat; Fig. 3, Hibernating den of Woodchuck.

XX. Fig. 1, Woodchuck with advanced malocclusion; Fig. 2, The daily food supply; Fig. 3, Mastology of lactating woodchuck; Fig. 4, A three hours kill of woodchucks with a rifle.

XXI. *Gerris dissortis* Drake and Harris, dorsal and lateral aspect.

XXII. *Gerris incognitus; G. insperatus; G. comatus,* ♂ and ♀; *G. buenoi; G. marginatus; G. gillettei,* ♀ and ♂; *G. pingreensis; G. incurvatus; G. argenticollis; G. alacris.*

XXIII. *Gerris conformis; G. nyctalis; G. remigis; G. notabilis; G. nebularis; G. dissortis; G. uhleri.*

XXIV. *Gerris canaliculatus; G. cariniventris; G. flavolineatus; Limnogonus hesione; L. guerini; Tenagogonus opacus; T. quadrilineatus; T. celocis,* ♀ and ♂; *Limnogonus recurvus; L. recurvus; L. aduncus.*

XXV. *Limnogonus celeris; L. hyalinus; L. recens; Gerris carmelus; Cylindrostethus erythropus; C. erythropus; C. linearis; C. regulus; Potamobates osborni.*

XXVI. *Potamobates bidentatus; P. tridentatus*, 4 views; *P. horvathi*, 3 views.

XXVII. Map of a portion of southwestern United States.

XXVIII. Relief map of Arizona.

XXIX. Contour map of southeastern Arizona.

XXX. Santa Rita Mountains and White House Canyon from mouth of Florida Canyon.

XXXI. Fig. 1, Near Sawtooth Mountain, Tucson Range (Lower Bajada); Fig. 2, Upper Bajada.

XXXII. Fig. 1, Santa Cruz River, near Tucson; Fig. 2, ditto.

XXXIII. Fig. 1, Sabino Canyon, Santa Catalina Mountains; Fig. 2, ditto.

XXXIV. Fig. 1, Near Oracle, Santa Catalina Mountains; Fig. 2, Sabino Canyon.

XXXV. Fig. 1, Florida Canyon, Santa Rita Mountains; Fig. 2, Near Mount Lemmon.

XXXVI. Fig. 1, Near Soldier Camp, Santa Catalina Mountains; Fig. 2, Gila Monster.

XXXVII. Fig. 1, Pack Rat's Nest; Fig. 2, Young Jack Rabbit; Fig. 3, Rock Squirrel.

XXXVIII. Fig. 1, Dolans Spring Ground Squirrel; Fig. 2, Badger.

XXXIX. Miocene Microfauna from Atrato River, Colombia.

XL. Miocene Microfauna from Atrato River, Colombia.

XLI. Miocene Microfauna from Atrato River, Colombia.

XLII. Miocene Microfauna and flora from Atrato River, Colombia.

XLIII. *Lithothamnium colombianum* (structural details).

XLIV. *Lithothamnium colombianum* (structural details).

XLV. Geological map of the Uinta Basin.

XLVI. Columnar section of Horizons and Stratigraphic section of the Uinta Basin.

XLVII. Conglomerates of the Duchesne River Formation.

XLVIII. Conglomerate at Asphalt Ridge (Duchesne River Formation).

XLIX. Duchesne River sandstones resting on variegated clays of Uinta C.

L. *Mytonolagus petersoni,* various figures.

LIST OF FIGURES IN TEXT

ART. II.

Fig. 1. A large burrow situated on a side hill..................125

Fig. 2. A long established den situated on a decided slope.....125

Fig. 3. Hibernating den of Woodchuck.........................126

Fig. 4. Adjoining Woodchuck burrows..........................126

Fig. 5. A large Woodchuck burrow.............................127

Fig. 6. Hibernating den of Woodchuck.........................127

Fig. 7. Hibernating den of Woodchuck.........................127

Fig. 8. A long established Woodchuck burrow..................128

Fig. 9. Captive Woodchuck showing progression of molt...... 140

ART. VII.

Fig. 1. *Protictops alticuspidens*..............................375

Fig. 2. (?) *Helohyus*..376

Fig. 3. *Mesagriochœrus primus*.................................378

Fig. 4. *Mesagriochœrus primus*.................................383

Fig. 5. *Mesagriochœrus primus*.................................384

Fig. 6. *Leptomeryx minutus*....................................386

Fig. 7. *Epitriplopus medius*....................................387

Fig. 8. *Hyracodon primus*......................................388

ART. VIII.

Fig. 1. *Leptotomus kayi*.......................................392

Fig. 2. *Protadjidaumo typus*...................................394

Fig. 3. *Adjidaumo douglassi*...................................395

Fig. 4. *Paradjidaumo minor*....................................397

Fig. 5. *Paradjidaumo nasutus*..................................398

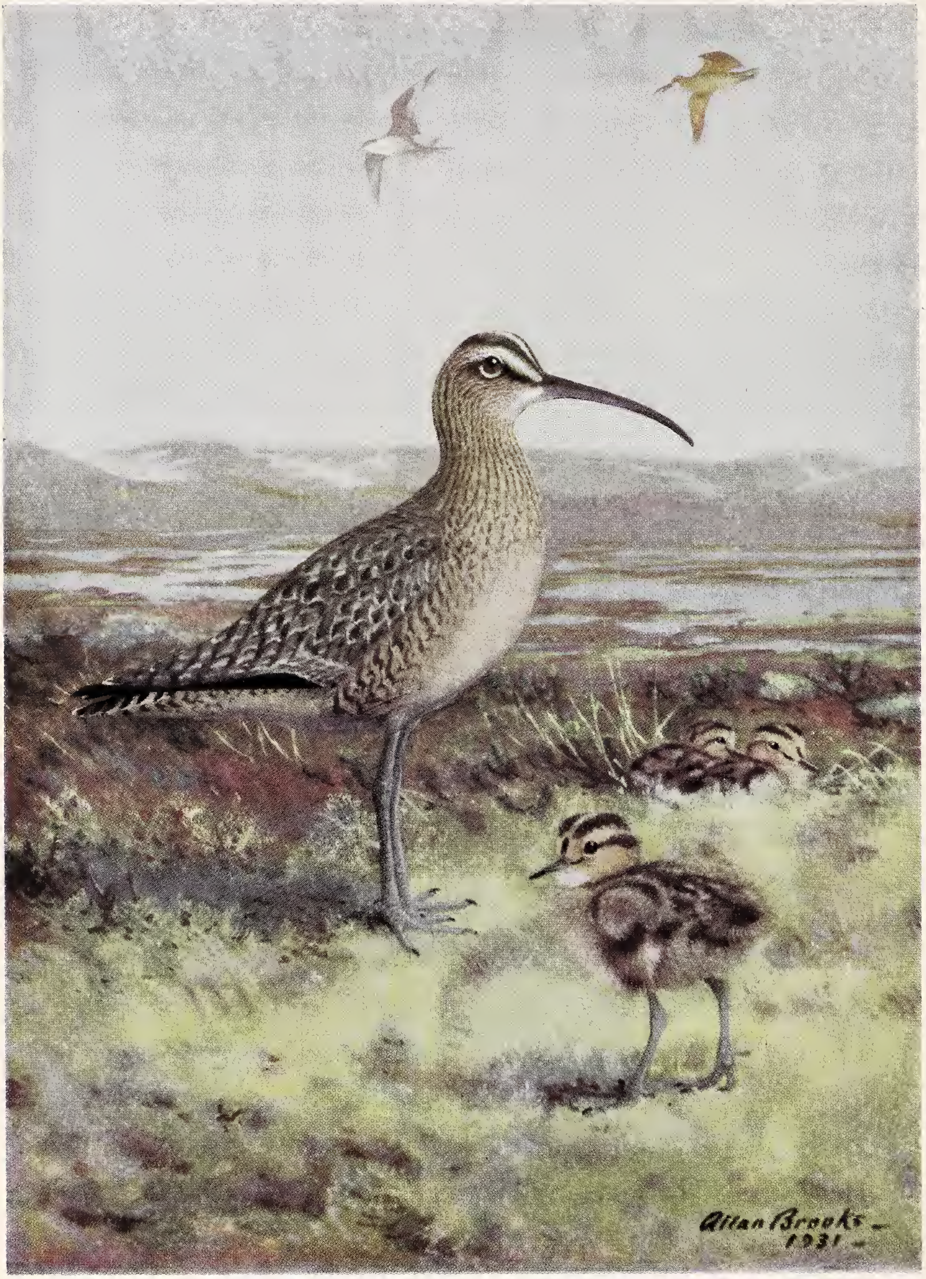
LIST OF GENERA AND SPECIES NEW TO SCIENCE DESCRIBED IN THIS VOLUME

Gerris kahli Drake and Harris, sp. nov.	Hemiptera	199
Gerris beieri Drake and Harris, sp nov.	"	200
Gerris summatis Drake and Harris, sp. nov.	"	201
Limnogonus ignotus Drake and Harris, sp. nov.	"	205
Limnogonus recens Drake and Harris, sp. nov.	"	207
Limnogonus genticus Drake and Harris, sp. nov.	"	213
Limnogonus celeris Drake and Harris, sp. nov.	"	214
Limnogonus visendus Drake and Harris, sp. nov.	"	215
Cylindrostethus hungerfordi Drake and Harris, sp. nov.	"	221
Cylindrostethus palmaris Drake and Harris, sp. nov.	"	222
Cytherella atrata Tolmachoff, sp nov.	Ostracoda	283
Heteropora elliptica Tolmachoff, sp. nov.	Bryozoa	287
Heteropora (?) amalgamata Tolmachoff, sp. nov.	"	288
Asterias (?) huntleyi Tolmachoff, sp. nov.	Asterozoa	289
Verneuilina fusiformis Tolmachoff, sp. nov.	Foraminifera	291
Quinqueloculina subquadrata Tolmachoff, sp. nov.	"	297
Lenticulina colombiana Tolmachoff, sp nov.	"	300
Lenticulina lens Tolmachoff, sp. nov.	"	300
Robulus lenticularis Tolmachoff, sp. nov.	"	302
Buliminella pulchra Tolmachoff, sp. nov.	"	305
Discorbis atratiensis Tolmachoff, sp. nov.	"	310
Eponides limbatus Tolmachoff, sp. nov.	"	315
Siphonina antioguiensis Tolmachoff, sp nov.	"	316
Siphonina chocoiensis Tolmachoff, sp. nov.	"	317

Globigerina tricamerata Tolmachoff, sp. nov. Foraminifera..324
Planulina bradii Tolmachoff, sp. nov. " ..333
Planula elegans Tolmachoff, sp. nov. " ..334
Cibicides colombianus Tolmachoff, sp. nov. " ..337
Cibicides atratiensis Tolmachoff, sp. nov. " ..338
Cibicides depressus Tolmachoff, sp. nov. " ..338
Cibicides concavus Tolmachoff, sp. nov. " ..339
Cibicides nephridium Tolmachoff, sp. nov. " ..340
Spermites fragilis Tolmachoff, sp. nov. Angiospermæ............341
Lithothamnium colombianum Tolmachoff, sp. nov. Algæ........343
Protictops alticuspidens Petersoni, gen. et sp. nov. Mammalia....373
Mesagriochœrus primus Peterson, gen. et sp. nov. " 377
Leptomeryx (?) minutus Peterson, sp. nov. " 386
Epitriplopus medius Peterson, sp. nov. " 387
Hyracodon primus Peterson, sp. nov. " 388
Leptotomus kayi Burke, sp. nov. " 391
Protadjidaumo typus Burke, sp. nov. " 394
Adjidaumo douglassi Burke, sp. nov. " 395
Paradjidaumo, gen. nov., Burke " 396
Mytonolagus petersoni Burke, gen. et sp. nov. " 400

ERRATA

p. 236. 2nd line from top for *carniventris* read *cariniventris.*
p. 247. 5th line from bottom for *macracarpa.* read *macrocarpa.*
p. 309. Foot-note 80 for 76 read 67.
p. 336. 2nd line from top for A. Petsso. read Asso. Pet.



Hudsonian Curlew and downy young.

I. THE BIRDS OF CHURCHILL, MANITOBA.

By Percy A. Taverner and George Miksch Sutton.

(Plates I-XIV.)

Historical Introduction.

In Lauridsen's highly interesting account (1883) of Jens Munk's explorations in Hudson Bay appears the reproduction of an old drawing—a picture full of action: men chopping wood near a tall, three-windowed, chimneyed house; men shooting some animal, a bear or caribou; men carrying a wounded comrade into a hut; still other men bringing in on their backs wolves or foxes from the forest. In the very center are two vessels close against the bank of the stream. This was Munk's Winter Harbor, where he and his men spent the winter of 1619-20: the winter that only he and two others survived.

The picture, in spite of its naïve proportions and perspective, its omission of many characteristic details, and its abundant and picturesque additions, is on the whole a faithful one. The course of the river, its narrowed mouth, the clumps of trees and bushes, Button Bay to the left and Cape Churchill to the right are all recognizable; for Munk's Winter Harbor was the mouth of the great river known today as the Churchill, and Munk's cabin stood on ground destined to become famous as the site of impressive masonry fortifications, of a prominent Hudson's Bay Company trading-post and, later, of an ocean port—the terminus of an important railway.

Fort Churchill was established as a Hudson's Bay Company trading-post in 1686 and, as the only good harbor on the west side of the Bay, has been an important point ever since. Many of the old accounts of the wild life of the north were probably based in part on experience at or out from this post. Samuel Hearne built Fort Prince of Wales from plans made by military engineers who had served under Marlborough. The remains of this fort, with their solid masonry and old guns, are still comparatively intact. Undoubtedly much of the information Hearne (1795) gives us of northern animal life was obtained here. Dr. John Rae probably stopped at Churchill before

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wintering at Repulse Bay, and it is not unlikely that some of the rather extraordinary records attributed to the latter locality in the *Catalogue of Birds in the British Museum* were made *en route*, much farther south. Many of the specimens that are historically attributed to "Hudson's Bay" probably came from the vicinity of Churchill. It is to be noted, however, that this and other similar trading-posts on the Bay were the commercial outlets for a vast and ever widening hinterland, even down to the present United States border; and that in the early days of generalized science the locality "Hudson's Bay" was likely to be attached to material that came out of any of them. Thus many of the birds figured by Edwards (1743-1751) as from Hudson Bay, and upon which Linnaeus based his names, were undoubtedly taken far south of their assigned type-localities, and in what are now the Provinces of Manitoba and Saskatchewan.

There is little matter of importance in the earlier authors that can definitely be linked with Churchill. Dr. Gillespie, Jr., a Company officer, made a collection of birds at Churchill which he presented to the Edinburgh Museum in 1845, and upon which W. Eagle Clarke (1890) reported. Seventy-seven species are named in the list and many of these have not since been recorded in the locality. During the 1880's Dr. Robert Bell, geologist of the Geological Survey of Canada, made several trips to Hudson Bay, touching occasionally at Churchill and making a few notes on the birds and mammals he encountered. Such specimens as he collected have since been lost or bear only the generalized locality of "Hudson Bay." It is not certain that all these were taken in the Bay itself rather than *en route* to the Bay in Hudson Straits or along the Labrador coast. J. M. Macoun, botanist of the Geological Survey of Canada, passed through Churchill during some of his northern explorations, collected a few fragmentary specimens, and has given us some random notes on the bird life. No further material addition to our knowledge of the fauna was made until 1900, when Mr. Edward A. Preble of the United States Biological Survey made a special investigation along the west shore of Hudson Bay. With his brother, Mr. Arthur E. Preble, he made Fort Churchill by way of Lake Winnipeg, the Hayes River, York Factory, and the coast of the Bay, arriving about the end of July. Leaving his brother to collect in the vicinity, he made his way northward to Cape Eskimo, returning to Churchill August 19. The two men left for home August 21. A full account (1902) of this trip has been given us. One of the most valuable features of the report is the exhaustive discussion and extensive bibliography of all previous biological work done in the Hudson Bay region.

RECENT WORK.

In 1930 the new Hudson Bay Railroad from The Pas, Manitoba, was nearing completion, and it seemed desirable to make a faunal survey of Churchill before the effects of commercial activity should seriously modify conditions there. Consequently, the senior author was directed to proceed with such an investigation. Accompanied by Mr. Albert C. Lloyd of Davidson, Saskatchewan, as assistant, he arrived at Churchill on May 26, 1930. Through the courtesies of the Department of Railways and Canals of the Canadian Federal Government, which had full charge of the port in making, camp was established on the rocky point between the townsite and the ruins of the old battery on the east side of the mouth of the river. The ground at this date was generally bare of snow, but heavy drifts remained in the gullies and sheltered nooks. The river was frozen as fast as in midwinter and traffic across it had not yet been interrupted. The Bay without was a continuous ice field, broken only by occasional open leads, shifting with the tide, and the horizon was thrown up into fantastic white pinnacles and frowning precipices by the distorting mirage. Flocks of Snow Buntings and Horned Larks fed familiarly about the doorsteps of the townsite; but few other migrants had appeared. On June 9 the party was joined by Mr. Victor E. Gould of Wolfville, Nova Scotia. From the Churchill camp, work was carried on mostly along the east side of the river, and within walking-distance inland as far as Landing Lake. After the ice left the river, June 10, several trips were made across the harbor to Sea Horse Gully, Button Bay, the vicinity of Fort Prince of Wales, and the old trading-post of Fort Churchill. Occasional expeditions were also made by canoe up-river and off the mouth of the harbor.

On June 18 camp was moved to Mosquito Point (well named), about seven miles up the west side of the river at the head of tidewater, and at the foot of the first rapids. From here the surrounding country was worked, especially along the river, and to Landing Lake, with occasional trips back to Churchill, th ebase of supplies.

On June 30 Taverner left on a Hudson's Bay Company schooner for Chesterfield Inlet, returning to Churchill July 11. In the meantime Lloyd and Gould had moved camp to the shores of Lake Rosabelle, some three miles south of the original camp and near the edge of the platted townsite, in a tundra lake region, the source of the townsite's water-supply, and adjacent to timber. On July 28 Taverner left for Ottawa. Lloyd and Gould moved back to the original Churchill camp on July 29, and across the river near Fort Prince of Wales on August 5. Gould left September 1.

On September 2 the junior author, returning from a year's sojourn on Southampton Island, had his first glimpse of Churchill. Making his way down the west coast of Hudson Bay on the Hudson's Bay Company's motor yacht *Nowya*, he reached Churchill just in time to gather a little first-hand knowledge of the bird life of the region and to help Lloyd in collecting a few specimens. It was at this time that he made definite plans to return to Churchill at the first opportunity, to find, if possible, the eggs of Harris's Sparrow. He left Churchill the following Monday, after having traversed with Lloyd much of the best collecting-ground. Lloyd continued his observations and collecting until October 4.

In 1931 two parties worked at Churchill. The first of these was under the direction of the Carnegie Museum of Pittsburgh, Pennsylvania. Mr. John Bonner Semple of Sewickley, Pennsylvania, and a Trustee of the Carnegie Institute, was leader. Other members were Mr. Albert C. Lloyd, mentioned before, Dr. Olin Sewall Pettingill, Jr., of Middleton, Massachusetts, and the junior author. This party reached Churchill May 24. With the assistance of the Department of Railways and Canals, camp was established on the site of the 1930 base camp near the mouth of the river. The whole countryside was snow-covered at this time, a drift just south of the ridge near camp being twenty feet deep. Camp remained here throughout the season, the members of the party walking daily from five to ten miles up-river, inland to the Landing Lake district, or along the railroad tracks. After the river opened, on June 11, a few trips were made by canoe to Button Bay, Fort Prince of Wales, and Mosquito Point. Semple and Sutton left Churchill July 6, leaving Lloyd and Pettingill to collect a few downy young of certain species and to take desirable photographs. Pettingill left and Lloyd ceased work on July 13.

The second party, consisting of Messrs. Arthur Twomey and Frank Farley of Camrose, Alberta, accompanied by Messrs. D. Twomey and Hugh A. MacGregor, arrived at Churchill on June 8. Farley left on June 22, and D. Twomey and MacGregor on June 29. Arthur Twomey remained until July 27. This party, with headquarters at the townsite, worked the surrounding country, tidal flats, tundra and bushland as far as Landing Lake, with occasional trips to Goose Creek some fifteen miles inland.

In 1932 Mr. Arthur Twomey returned to Churchill on May 29, remaining until July 26, with the exception of three days, July 6, 7, and 8, that were spent investigating the Fox Islands.

In 1933 three ornithologists worked in the Churchill region: Mr. Arthur Twomey, from June 5 to July 24; Miss Marguerite Heydweiller, of Rochester, N. Y., from June 5 to August 1; and Mr. Frank Farley, from June 12 to June 19. Twomey and Miss Heydweiller collected throughout the Churchill neighborhood and made one trip, July 3 to 8, to Cape Churchill, some thirty miles to the east. They found the season late. There was much snow on the ground on June 5, the heavier drifts being ten feet deep.

Miss Heydweiller made an intensive study of the nesting-habits of the Tree Sparrow in connection with graduate work at Cornell University.

Lemmings were found to be unusually abundant during the summer of 1933. During our first season's investigations (1930), all small mammals were decidedly rare, though old tunnels and runways in the moss indicated abundance during a preceding year. A comparison of notes for the years 1930 and 1933 furnish interesting evidence of the effect of food-supply upon distribution of such raptorial species as the Snowy Owl, Short-eared Owl, and Rough-legged Hawk.

DESCRIPTION OF COUNTRY.

Churchill is situated at the mouth of the great river of the same name, a little over halfway up the west side of Hudson Bay, in the more northern of the two conspicuous indentations of that smooth coastline, in latitude about 58° 45′ North. Here occurs the only rocky outcrop and practicable harbor that breaks the hundreds of miles of shoal, alluvial shore; here the river empties due northward into the Bay between the approaching tips of two pre-Cambrian quartzite ridges; and here there are scanty remains of an original limestone capping, now eroded away, which never within historical times was sufficient to affect appreciably the landscape, its fauna or flora.

On the west bank of the river-mouth, projecting in a long, narrow point that bounds Button Bay on its outer side, a ridge of rounded granite rises from the general level to a height of 125 feet at its outward end. This ridge is broken a short way back by the tundra and muskeg of Sea Horse Gully, that forms a low land connection between the harbor and Button Bay. The point terminates in low sand-dunes, from which the impressive ruins of Fort Prince of Wales still dominate the harbor entrance. Off the tip of the point lies a low sand-bank, Eskimo Island. Up the river, within a few miles, shortly beyond Mosquito Point, the ridge of rock gradually sinks to the general tundra-and-muskeg level of the interior.

On the east side of the river the rocky backbone of the long, narrow point that separates the river from the Bay is lower and less bold, fifty to seventy-five feet in elevation, and is more or less buried in gravel deposits. The terminal point is rugged, broken rock, upon which are perched the remains of the old battery and powder magazine that complemented the fort opposite in the historic defenses of the harbor. The ridge runs through the townsite in solid masses, sinking below the tundra within the townsite limits.

The entrance to the harbor is constricted, being only about half a mile wide; but the basin within, as far as Mosquito Point some eight miles up-stream, widens out considerably. At low tide this basin averages about two miles wide, with broad mud-flats on either hand, liberally sprinkled with erratic, upstanding boulders, the largest as big as hay-cocks. At high water the river widens approximately a mile on both sides, but must be navigated with due care for hidden obstructions. Bordering the tidal mud-flats are wide, bare or scantily grassed clay-flats. These blend into the higher mossy barrens, whence rise the rocky ridges or gravel banks that lead to the general tundra level at about twenty-five feet elevation.

"Fort" Churchill, the historic trading-post of the Hudson's Bay Company, is a group of neatly white-painted buildings and a little church, on the west side of the river, about five miles from the mouth, built on the gently rising slope between tidewater and the rocky ridge, on a little hook-like point. To the south it overlooks an immense expanse of intertidal mud, and to the southwest broad, meadow-like flats.

The Port of Churchill, the new townsite, Mile 511, at the end of steel of the Hudson Bay Railroad, is on the east side of the river, occupying, within its platted lines, four miles of the rock ridge, tundra, and meadow flats of the narrow terminal point.

At the time of our first visits, Churchill consisted of workshops, bunkhouses, mess-houses, and administration buildings, scattered over several miles of platting, but strung together with makeshift roads and a network of narrow-gauge tracks. Reeling, puffing "dinkey" engines scurried about, pulling or pushing overladen trains of gravel, timber, and other rough construction material. Everywhere were men at work with transit, shovel, or hammer. On the river, dredges were deepening the channel and sending off barge-loads of bottom mud to be dumped at sea. On shore, barges, docks, grain-elevators, round-houses, and freight-sheds were being built with feverish haste while the short summer lasted. Inland, steam-shovels were levelling off the gravel ridges as fast as the frost could be coaxed from the ground; marshes were being filled; and drag-line outfits were scooping a reservoir out of the tundra for the permanent water-supply. It was a busy scene. In this wild, subarctic setting, a modern ocean port, with all its accessories, was rising. Within a few short months a gigantic project was becoming reality. On these inhospitable barren grounds, a task that normally would demand years of labor was being accomplished in months.

In the very heart of all this confusion and activity was a shallow, lagoon-like, muddy slough, several acres in extent, with meandering outline. Here many observations upon waders and other birds were made. The slough is referred to in the succeeding pages as the "townsite" or "Churchill" slough; it is a place of many pleasant memories. Unfortunately, however, it is adjacent to the elevator and docks and is destined to become a switching-yard. It will be filled up, levelled off, and covered with oily trackage, and as a place of ornithological interest cease to exist.

Churchill was, and is, a busy, noisy place. Yet one has only to walk a few steps from the center of activity to find one's self in a primitive wilderness. No farther than a mile away Churchill becomes only a smudge of smoke and an incongruous bit of sky-line. The age-old tundra rules to the very edge of the right of way. The waders and longspurs go about their affairs undisturbed by softened whistles and sounds from afar. Nor are they likely soon to be seriously disturbed. The only roadways out of "town" are now mere traces, rapidly being obliterated, where caterpillar trucks passed in the early construction days, and heading into country which no one now has reason to visit. Today there is no objective to road-building for many hundreds of miles. The only transportation, besides the railroad and the rapid river, is by foot in summer and by dog-team in winter. Modern industrialism may invade the tundra, but its influence does not extend far.

Faunally, Churchill stands at the junction of two life zones. It is precisely at the limit of tree growth, where the spruce forest dies out on the arctic tundra and both types of biological association are in contact. The country south of the townsite is bare, mossy tundra, in which the foot sinks as in a cushion. In spring it is soft and boggy with melting snow, but the surface of the higher levels dries to a state of aestivation later in the season. Fronds of juniper, crowberry, and lowly willow, hugging the ground or draping the sheltered crannies, compose the principal shrubby elements of the flora. Dwarf spruces, gnarled and twisted from their years of fighting with the hostile elements, stand widely scattered or grouped in matted friendliness in clefts and sheltered hollows, the advance guard or spiers-out of the serried forest hosts that are continually struggling to extend their domain. Inland, the trees increase in number and in size, especially on warm, well drained declivities and along the river, where the bush is more or less continuous, and where spruce and tamarack with trunks eight or ten inches in diameter may be found.

Everywhere is evidence of an undeveloped drainage system. Shallow ponds of irregular outline, with abrupt mossy edges and no appreciable outlet, dove-tail into each other on the broad, flat levels. Perpetual ice lies within three feet of the surface of the soil, dwarfing the trees by limiting their root growth and forming an impervious substratum which prevents the ground seepage that should develop drainage channels. Every hollow, whether in porous moss or dense clay, holds water like solid rock, and this water, instead of cutting through permeable retaining ridges, tends to build them up with ice-formed dams, preventing rather than developing outlets. The tundra ponds are of the clearest water, with clean, firm, gravel bottoms and without vegetable growth. Since they freeze to the bottom in winter, they contain no fish and very little other animal life. Typical of these ponds is Lake Rosabelle, one of the group of lakelets at the edge of the townsite, approximately one-half by one-third of a mile in extent. Here the 1930 party had their camp for a considerable time. Landing

Lake, often mentioned in the following list, is a much larger body of water, some one by two miles in size, four miles south of the town line and about two miles from the river. It is surrounded by considerable spruce and tamarack bush, deep muskeg bogs, higher open land, and many shallow surface pools. Along part of one side is a grassy marsh, and alder thickets fringe the ends.

The rock masses that rise through the tundra are bare, austere granite, with little mossy valleys and ponds and pools in their hollows. Clumps of scrubby, matted spruce crouch in their sheltered nooks or climb their warmer gravel shoulders.

The characteristic birds of the open barrens are the ubiquitous Longspurs—the Lapland by far the more common, Smith's much less so. A few waders nest here and there on the higher ground, but their favorite haunts are the lower levels adjoining the tidal flats. As the ground dries with the advancing season, or as the young hatch, these waders gradually drift riverward; but strangely enough, at least up to the beginning of the autumnal migrations, they are practically never found on the tidal flats, in spite of the fact that these flats are apparently an ideal feeding-ground. On the ponds of the open country the Old-squaw is the bird most often seen, but Arctic Loons are not uncommon, and a colony of Arctic Terns is known to nest on an islet in one of them. Inland the bush-girt lakes are inhabited by Bonaparte's Gulls, Bitterns, Sora Rails, and other species not commonly seen elsewhere. In the shrub-covered areas of the forest-edge Tree Sparrows and Redpolls are the most noticeable species; while deeper in the woodlands live Gray-cheeked Thrushes and Black-poll Warblers. The higher bare outcrops of rock are inhabited principally by Pipits, while the scrub about them harbors White-crowned and Harris's Sparrows. Other species of land birds present are few in number and local in distribution. During the period of our field work a flock of gulls, mostly Herring Gulls, continually lingered about the river-mouth with the Arctic Terns and a group of Parasitic Jaegers that eternally badgered them. The river itself, immediately after the break-up of the ice, fairly swarms with ducks and loons of various species, but these soon depart and through the summer the only birds commonly seen on it are a few Arctic Loons and occasional Black Ducks.

Some nineteen miles east of Churchill are the Fox Islands: two tidal islets of very unequal size, the larger about a mile in length and a quarter of a mile in greatest width. They lie some four miles off the high-tide shore in the midst of a boulder-strewn tide-flat about ten miles wide, and are completely insular only when the tide is in. The larger island rises about twelve feet above high tide, and, except for one small sandy beach, has rocky or bouldery shores. It is generally level on top, is heavily grassed, and contains two shallow fresh-water ponds, the more important of which is approximately seventy-five by two hundred yards in extent. This larger pond is fringed with reeds and tall grass, and at one end there are some low arctic willows.

Cape Churchill is the extreme northern tip of the first strong salient of the west coast, about thirty miles east and a little north of Churchill. Twomey in 1933 (July 3-8) established headquarters on one of the small islands off the Cape, and made several trips along the adjacent coast and a short way inland. He describes the mainland around the Cape as low and covered with flat gravel and sand-dunes interspersed with numerous lakes, the country tending to become more level and sandy towards the south. He noted no evidence of forest growth from the coast but was informed that the tree-line lay some fifteen miles back from the shore. He saw many large icebergs among the shifting ice fields that completely surrounded the Cape.

Annotated List of Species.[1]

In the following list the senior author is responsible for the account, quotations, and conclusions recorded under the paragraphs covering 1930 and 1932, and the junior author for those pertaining to 1931. Wherever differences of opinion or observation exist both sides with the authority for each are given.

1. **Gavia immer** (Brünnich). Common Loon.

A regular but not common transient. Though loons were numerous on the river and on many tundra ponds throughout the summer of 1930, this species was positively identified but once, June 19, when a female was taken.

During 1931 loons thought to be of this species were seen three or four times, but only one was positively identified. This individual was noted by Sutton, June 19, near the river-mouth after a severe blizzard from the northeast. None were detected nesting on any of the lakes. Familiar loon calls were heard continually, but never the well-known laugh which is characteristic of *immer* but not of *arctica*.

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[1] The scientific nomenclature and sequence of species used in this paper follow those of the American Ornithologists' Union "Check-List of North American Birds," Fourth Edition, 1931. As that work provides no official vernacular specific names, we have used our own discretion in adapting names for the purpose as has the senior author in his several official works.

Mr. L. T. S. Norris-Elye of Winnipeg, Manitoba, informs us that he received an unsexed specimen of this species taken at Churchill during the season of 1932.

On July 7, 1933, Twomey examined a Common Loon that had been shot by a trapper about ten miles down the coast from Churchill. This appears to be his only record for the species.

Measurements of the female specimen taken in 1930 are: wing, 330 mm.; culmen, 72 mm.; tarsus, 88 mm. These are small for the species and indicate a typical Lesser Loon, *G. i. elasson*, postulated for the interior and western parts of the continent.

2. **Gavia arctica** (Linnaeus). ARCTIC LOON.

Common transient and summer resident; breeds. Noted many times during the summer of 1930 from June 10, when the ice went out of the river, onward. Often seen on the lower river and on the tundra ponds where it nested. Two nests found, the eggs in one hatching July 15.

This loon seems just as fond of visiting its conspecific friends on adjoining waters as the Common Loon. Evenings, upon our first arrival at Lake Rosabelle, a number made rendezvous there and six or seven birds might be seen companionably swimming together and talking loudly. None were known to be nesting on this particular lake, though one nest was found on an islet in an adjoining pond. After being disturbed a few times the congregation discontinued their meetings or held them elsewhere. These lake and pond waters are shallow, seldom over six feet in depth, and in winter freeze to the bottom. They have no well defined outlet or other practicable connection with deep water and so far as we know contain no fish or noticeable amount of other loon food. The birds probably obtain their food from the river or sea nearby and carry it to their young on the ponds. Many of the calls of this species seem indistinguishable from those of the Common Loon, but we never heard them give the long, weird laugh that is so characteristic of *immer*. The species was observed rather commonly through August and occasionally in September. The last was recorded with a query, on October 3, by Lloyd.

During 1931 the species was very rare prior to the breaking up and going out of the ice on the river. On May 29 a single bird was noted on one of the lakes not far from the townsite. On June 10 two birds, probably a pair, were seen at high tide at the river-mouth. On June 11 the river became free of ice. On June 13 a spectacular sort of migration of loons took place all along the river. Most of these birds, apparently, were Red-throated Loons, but there were many Arctic Loons among them. They all behaved as if much elated over the opening of the river. Calling loudly, they passed back and forth all day in pairs and small flocks, sometimes as many as a hundred being visible at one time. They appeared to be issuing endlessly from the interior; but by following certain individuals, we could see that many of them were circling over the Bay, flying overland back to the river, and thence down once more to the mouth.

On June 16 and 17 several pairs were seen in the Lake Rosabelle district. On June 20 a nest just ready for eggs and one pair of birds were noted by Sutton and Lloyd at Landing Lake, and on June 23 a pair were seen on a lake near the gravel-pit. On July 6, 1933, Twomey found a nest with two eggs at Cape Churchill.

All specimens taken are referable to the American race, *G. a. pacifica*, the so-called Pacific Loon, found throughout most of the American range of the species.

3. **Gavia stellata** (Pontoppidan). RED-THROATED LOON.

Common transient; apparently does not breed. During 1930 Red-throated Loons became common as soon as the river opened, on June 10. Loons continued to be common on the river throughout the summer, but were difficult to approach, and this species was not positively identified after June 20, though Preble records it as "fairly common" at Churchill on July 21. We were surprised not to find this species breeding here, for it does so commonly at considerably lower latitudes, notably on the north shore of the Gulf of Saint Lawrence, where similar ecological conditions obtain.

In 1931, before the ice of the river went out, this loon was noted much more frequently than was the Arctic Loon. On May 29 four birds, probably two mated pairs, were seen flying over. On May 30 four pairs were seen and one very fat male shot. On June 2 several were noted. On June 5 a pair were seen. On June 6 Lloyd shot a male at the river-mouth. On June 13 great numbers of loons, as described under the preceding species, were seen moving about the mouth of the river, apparently *en route* to more northerly nesting-grounds. Most of these were undoubtedly Red-throats, probably in a ratio of about one hundred to one. On June 17 two were seen on one of the lakes near the coast northeast of Lake Rosabelle. On June 28 four were seen on the river while we were on our way to Mosquito Point. No nests of the species were located.

In 1933 Twomey observed a heavy flight of this species from June 12 to 15, similar to that noted at about the same time of the month in 1931. He says: "At one time during these dates I counted as many as one hundred and fifty in and about the mouth of the river."

4. **Colymbus auritus** Linnaeus. HORNED GREBE.

Rare summer resident; breeds locally. It was not noted in 1930, although Clarke (1890) records a specimen in summer plumage taken prior to 1845.

On May 27, 1931, Semple saw one on the slough at the edge of the construction camp and his sight identification was later confirmed when, on June 20, Lloyd and Sutton located a nesting pair at Landing Lake and collected six fresh eggs and the incubating female. The nest was built between the slender trunks of some alders in a quiet corner of the lake, in water not more than four feet deep. The birds were very wary. The eggs were so fresh that they were not badly nest-stained. The condition of the ovaries of the female indicated that one, and perhaps two, more eggs would have been added to the set.

5. **Podilymbus podiceps** (Linnaeus). PIED-BILLED GREBE.

Mr. L. T. S. Norris-Elye of Winnipeg informs us that he recently received from Mr. Hugh Conn of the Hudson's Bay Company the skin of a Pied-billed Grebe taken at Churchill, presumably during the summer of 1933.

6. **Botaurus lentiginosus** (Montagu). AMERICAN BITTERN.

Rare summer resident; breeds locally. Recorded several times in the Landing Lake district during 1930. A female taken June 28 contained eggs nearly ready to deposit. Seen almost daily (probably the same individuals) until July 25; a single bird noted September 30.

In 1931 the Bittern was recorded only four times. On June 6 Lloyd saw one along the river about seven miles from the mouth, and Sutton saw another at a woodland pool. On July 1 one was observed near Landing Lake. Twomey collected one near Goose Creek on July 12.

The species was recorded several times in 1932 and 1933.

7. **Cygnus columbianus** (Ord). WHISTLING SWAN.

Probably a regular transient, much rarer now than formerly.

Bell (1883) reports Whistling Swans breeding near Churchill and on islands towards the eastern side of Hudson Bay, stating that their breasts are an article of trade although only small numbers are collected annually.

In 1930 swans were seen or reported flying over the river on June 3, 4, 10, and 16. On June 10 eleven birds were counted.

In 1931 swans were seen several times. On May 27 two were noted flying toward the open water of the Bay, and on May 29 two more were seen flying over the ice-covered river. On May 30 seven were observed flying toward the river-mouth, and on June 2 a pair and a flock of four were seen near the river. On June 6 six (perhaps the same birds that were noted on the 2nd) were seen. On June 8 a flock of nine was noted, one of which was a grayish, immature individual.

In 1932 Twomey noted four at Lake Rosabelle on June 7; two flying over Churchill on June 8; and one at Landing Lake on June 10.

In 1933 swans were noted in greater numbers than during the three preceding years. From June 7 to 18 flocks of from six to twenty individuals were seen almost daily flying down the river and out into the Bay, where they often settled. Reports that swans were nesting some distance up-river were not substantiated.

Cygnus buccinator Richardson. TRUMPETER SWAN.

Hypothetical. Possibly, in former times, an occasional visitor this far north. Bell (1885) lists the Trumpeter Swan from Churchill, but confidence in the record is shaken by his extending the range of this relatively southern species north to Marble and Nottingham Islands, where the Whistling Swan is known to be a common species today. We understand that in the early days, when swan skins were a recognized article of the fur trade, two sizes of swan pelts were commonly known to come out of Hudson Bay. The larger ones were undoubtedly of Trumpeter Swans, but there is no certainty that these birds were not captured much farther south in the interior, the pelts filtering by trade to the established commercial outlets.

8. **Branta canadensis** (Linnaeus). CANADA GOOSE.

B. c. canadensis is a common transient, which breeds sparingly in the vicinity.

During the spring of 1930, Canada Geese were seen occasionally as late as June 24, but not thereafter. One was taken from a flock on June 19, but no definite evidence of breeding was obtained. Canada Geese were noted again on August 28, and migratory flocks of from twenty-five to one hundred individuals were seen intermittently until the end of September.

In 1931 many more birds were seen than in the previous year; they were noted almost daily throughout the period of observation. A flock of four was seen May 22. On May 24 and 25 several flocks of from four to sixty birds were observed, all flying northward. On May 27 several flocks were seen, some individuals of which appeared to the junior author to be of smaller size than the others. These smaller birds may have been *B. c. hutchinsi.* On May 28 a pair flew over headed for the woodland, not migrating northward, and on May 29 many birds were observed, some in pairs in the woodlands, others in flocks moving northward, high in the air.

On June 2 Lloyd collected a pair of large *B. c. canadensis* as they flew from the woods out to their favorite feeding-grounds on the tidal flats. The gonads of these birds were much swollen. Between June 4 and 20 numerous birds were seen singly, in pairs, and in small flocks, many of them being agitated as if over the safety of their nests. On June 16 Sutton found a large female (again plainly *B. c. canadensis*) with bare incubation patch dead at the edge of a tidal stream.

On July 1 Pettingill encountered three pairs of geese with young in the woodlands of the Landing Lake district. Since none of the adults attempted to fly, they were probably in mid-summer moult, though no definite datum was recorded as to the condition of their wings. The young stayed with the old birds, making their way to water. They dived well at first, progressing rapidly a short way under the surface; but they soon became tired and on trying to get under again were unsuccessful. Specimens of the young were obtained.

In 1932 Twomey saw a flock of about thirty July 6 to 8 off the Fox Islands, some nineteen miles to the east. They were very wary and kept off the island while he was there and gave no definite evidence of nesting.

In 1933 Twomey found them breeding on the little lakes about Cape Churchill. The species was very numerous there and he noted four or five hundred birds.

It is apparent from the evidence and specimens at hand that the large Common Canada Goose, *B. c. canadensis*, is the breeding form of the locality. The occurrence of the smaller Lesser Canada Goose, *B. c. leucopareia*, and the diminutive *B. c. hutchinsi* as transients is indeed very likely, but actual specimens of these forms have not yet been collected.

9. **Anser albifrons** (Scopoli). WHITE-FRONTED GOOSE.

Preble (1902) tells us that Barnston recorded the White-fronted Goose as "frequent at Fort Churchill." This is quite possible, but we have no substantiating evidence today. It will probably be found, on receipt of specimens, that the smaller, typical *A. a. albifrons*, common to most of the continent, is the race present in this region, though a late author identifies a British Museum specimen from Repulse Bay, some six hundred miles to the north of Churchill, as *A. a. gambelli* (cf. Kuroda, 1929).

10. **Chen hyperborea** (Pallas). SNOW GOOSE.

Regular transient. Bell (1880) reports the "common white wavy" as "abundant at Churchill and York during the spring and autumn migrations." Again (1885) he says "Beginning to arrive at Churchill 5th September." The species appears not to be so common now, however.

In 1930 a flock of six was seen passing overhead on June 4, the only observed occurrence that year.

In 1931 a flock of four flew directly northward over the frozen river on May 29. On June 1 a large flock headed northeastward across the Bay at sunset. On June 3 a small, north-bound flock passed over the river-mouth. No Blue Geese were observed in these flocks.

Since no evidence that the Greater Snow Goose, *C. h. atlantica*, occurs anywhere on Hudson Bay is conclusive and since there is no indubitable record of that form from the west side of the Bay, we can confidently refer these birds to the Lesser Snow Goose, *C. h. hyperborea*.

Chen rossi (Cassin). ROSS'S GOOSE.

Hypothetical. Probably formerly a rare straggler. Hearne (1795, *vide* Macoun, 1909), who describes the "Horned Wavy" and makes clear the differences between it and the "Common Wavy," declares that it is very scarce at Churchill. Bell (1880) under the name "*Chen hyperboreus* var. *albatus*, Lesser Snow Goose," may refer to this species when he reports one shot at Fort Churchill by Mr. J. R. Spenser and comments on its rarity. Immediately afterwards he lists the "Common Wavy" as abundant. Since the common and abundant Snow Goose of Hudson Bay is the Lesser and as there is no other similar goose that is smaller except Ross's it is not unreasonable to suppose that it is this species he intends to designate. The taking of stray specimens in southern Manitoba in 1901 and 1902 (Macoun and Macoun, 1909) indicates that when the species was more abundant than it is now it did occasionally stray eastward from its normal migration range, and lends color to the supposition that it might have appeared occasionally at Churchill.

11. **Anas platyrhynchos** Linnaeus. MALLARD.

Clarke (1890) lists an adult male Mallard taken at Churchill sometime before 1845. The species was not recorded with certainty in 1930.

In 1931 it was noted several times. On June 6 Lloyd saw a large flock composed principally of green-headed males. During the following three weeks both males and females were observed now and then, though no definitely mated pairs were noted nor were nests or young found. On June 28 Pettingill took an interesting specimen of a male in eclipse plumage on a pond at Mosquito Point. It was unable to fly and was exceedingly difficult to prepare as a specimen.

12. **Anas rubripes** Brewster. BLACK DUCK.

Common summer resident; probably nests. Specimens taken June 10 and 19, 1930, were flightless, with moulted wings, and all birds taken after the first date were males. The assumption is that the females were nesting, probably inland beyond our sphere of activity; but we obtained no direct evidence of breeding. Considerable numbers, flocks of as many as sixty birds, were noted during the first half of August, but the species became rarer thereafter. The last record is of twenty-five seen on October 4.

In 1931 the Black Duck was first recorded on June 2, when a flock of six was noted by Lloyd. Probably the same birds were seen again on June 6. On June 8 several flocks, totalling at least fifty individuals, were noted. On June 12 several flocks and what appeared to be a few mated pairs were seen along the river and in woodland ponds. From June 15 to 20 single birds, probably males, and pairs were to be seen here and there on the woodland pools, and on June 20 a few pairs were observed in the Landing Lake district. On June 29 Semple took an eclipse male at Mosquito Point. The bird was unable to fly and was swimming about in the river several hundred yards from shore. Another bird, probably also a male in eclipse, was seen nearby, but no females nor young were noted.

In 1932 Twomey observed about a thousand in scattered flocks on July 7, and five hundred more on July 8, all on and in the vicinity of the Fox Islands.

In view of the rarity of the Black Duck in southern Manitoba, the occurrence of the species in some numbers at Churchill is something of a surprise. The species probably migrates along the shores of Hudson and James Bays and southward through Ontario.

The legs of all birds that passed the eye of the senior author at the time of collection were decidedly red. The colors named from color-sketches made at the time were as follows. Legs: between bitter-sweet pink and oriental pink (Plate II, Ridgway's "Color Standards and Color Nomenclature," 1912) with dusky webs and joints. Bills: Rinnemann's green (Plate XVIII). The birds are therefore clearly within the description requirements of *A. r. rubripes*, the Red-legged Black Duck.

Chaulelasmus streperus (Linnaeus). GADWALL.

Mr. A. C. Bent, in his "Life Histories of North American Wild Fowl" (1923) cites this species as breeding north to Churchill but gives no authority for the statement.

13. **Mareca americana** (Gmelin). BALDPATE.

Fairly common summer resident; breeds. During 1930 a number of nests were found. The last bird recorded during the season was taken on September 30.

In 1931 Baldpates were seen nearly every day, the first individuals, probably a mated pair, being recorded on May 28. On June 15 Lloyd found a nest and ten fresh eggs under a small spruce tree. On June 29 many adults were seen at Mosquito Point. During the course of the season several specimens were collected.

14. **Dafila acuta** (Vieillot). PINTAIL.

Common summer resident; breeds. During 1930 this was considered one of the commonest ducks of the summer and early autumn. It was first noted on May 30. Occasional birds were recorded through July to the 25th, when the numbers jumped from two to four a day to twenty-five and fifty, increasing by the middle of August and the first week of September to one and two hundred. Few were noted thereafter until September 29, when five hundred were recorded. Seven were observed on October 3, when the record closed. A number of nests were found.

During 1931 the Pintail was considered the commonest of the ducks. The species evidently arrives early, for on May 25 we saw not only a mated pair on the townsite slough, but also a flock of five passing northward over the frozen mouth of the river. On May 26 a male was shot, its back already containing a few feathers of the eclipse plumage. On May 30 a female with a fully formed egg in the oviduct was taken, and on June 2 a male in almost full breeding plumage, but with a few eclipse feathers in the back and scapulars. The first complete set of eggs, nine, slightly incubated, was found on June 6. By June 12 male Pintails were beginning to fly by themselves or in little companies. On June 15 it was noticed that female birds that had just left the nests were promptly joined by males. On June 17 a flock of males was noted in which at least two individuals were in almost complete eclipse plumage though all could fly perfectly. On June 26 a moulting female was taken at Button Bay and on June 29 three females with small young were noted. By this time separate flocks of male birds were to be seen everywhere along the river.

15. **Nettion carolinense** (Gmelin). GREEN-WINGED TEAL.

Regular though not very common transient; probably breeds occasionally. During 1930 it was not common during summer, but became somewhat more abundant in the fall. On June 28 two were seen by Gould; on June 30 a juvenal female was taken; and on August 8 an adult female was collected. Lloyd saw birds occasionally through August and September, and on September 4 and 30 saw flocks of forty and one hundred birds respectively. We obtained no definite evidence of breeding.

During 1931 the species was recorded on four dates. On June 6 a solitary male was seen by Lloyd. On June 8 Sutton collected a male in full courting plumage on a small woodland pool, but no female was seen nearby. On June 26 a flock, most of them apparently males, was seen at Button Bay. On June 29 a male was seen at Mosquito Point.

In 1932 Twomey saw single birds on the townsite slough on May 29 and June 5, collecting the latter. On June 14 he saw a pair on Lake Rosabelle. In 1933 he observed several individuals, mostly males, in and around the townsite during June and July.

16. **Querquedula discors** (Linnaeus). BLUE-WINGED TEAL.

Rare summer resident; nests. Preble (1902) tells us that a specimen from "Repulse Bay" is recorded in the British Museum Catalogue of Birds. The chances are this specimen was collected by Rae and that it came from some point considerably south of Repulse Bay, presumably in wooded country rather than in the Barren Grounds.

Twomey saw a female with a brood of young on July 12, 1931. He observed these birds at close range and is quite confident of their identity.

17. **Spatula clypeata** (Linnaeus). SHOVELLER.

Summer resident; breeds occasionally. In 1930 we observed it infrequently, first on June 8, when four males were seen in the townsite slough. On July 25 a downy young was taken by Lloyd at Landing Lake, this specimen furnishing evidence that the species breeds in the vicinity.

In 1931 Shovellers were recorded several times, but no nests were found. A male in worn breeding plumage was taken by Lloyd from a flock of three seen on June 2. On June 8, and on several dates thereafter, a pair were seen at the edge of town; the female probably had a nest not far away. Solitary males were noted at the mouth of a creek about seven miles up-river on June 12. The species was last recorded on June 21.

Mr. L. T. S. Norris-Elye of Winnipeg informs us that a specimen in his collection was taken at Churchill during the season of 1932.

18. **Nyroca marila** (Linnaeus). GREATER SCAUP.

Transient and summer resident; breeds occasionally and perhaps regularly. In 1930, from the time the ice went out of the river to the end of June, Scaups were common on the river. All specimens taken were Greater Scaups and the rest were assumed to be of the same form. Gould took a female with an egg in the oviduct on June 13, and a nest with eggs and parent on June 27. No Scaups were noted after June 30 except one seen by Lloyd on September 30.

In 1931 Scaups were recorded several times, and although the collecting of a single specimen of Lesser Scaup proves that both species occur, most of the birds seen were Greater Scaups. On May 25 a mated pair were seen swimming about at the river-mouth. Another pair continued to be seen about the townsite slough from May 26 to the end of the month. On May 30 a male was seen at the mouth of the river. On June 2 Lloyd collected a pair from a flock of forty about seven miles up-stream. The gonads of these were very small. On June 10 Sutton found a male in full plumage dead from striking telegraph wires. On June 17 a wary pair were seen on Lake Rosabelle. On June 29 three females and a male, all able to fly, were noted at Mosquito Point. On July 4 a pair were seen on Lake Rosabelle. No nest or female with young were found during this season.

In 1932 Twomey found the species common and took several specimens.

19. **Nyroca affinis** (Eyton). LESSER SCAUP.

Uncommon transient; may nest occasionally. The species was not recorded during 1930. In 1931 Lloyd collected a female on June 2. The ovaries of this specimen indicated the possibility of its nesting, but no male was seen nearby and no further evidence of nesting was obtained. Twomey noted two birds on July 12 that, on the basis of apparent size, he referred to this species.

20. **Glaucionetta clangula** (Linnaeus). GOLDEN-EYE.

Occasional visitor; probably does not breed. The absence of timber large enough to furnish nesting-holes would preclude its regular breeding in the vicinity. Macoun (1909) reports a Golden-eye from Churchill, but the specimen cannot now be located in the collections of the National Museum of Canada. We did not meet with it in 1930.

During the summer of 1931 the species was recorded on three dates: June 24, a flock of eight, apparently all males, swimming in the Bay not far east of the mouth of the river; June 26, two at the river-mouth; and June 29, two at Mosquito Point. These were carefully identified with good glasses.

In 1933 Twomey saw many flocks of from ten to twenty individuals at Cape Churchill, July 3 to 8, and collected a male in eclipse plumage.

21. **Charitonetta albeola** (Linnaeus). BUFFLE-HEAD.

Probably an occasional straggler. A specimen from Churchill taken previous to 1845 and reported by Clarke (1890) is our only record for the locality. There is no timber suitable for the nesting of this species anywhere in the immediate vicinity.

22. **Clangula hyemalis** (Linnaeus). OLD-SQUAW.

Very common transient and summer resident; nests abundantly. The Old-squaw and Pintail are the commonest ducks of the vicinity. In 1930, during spring and early summer, one or more pairs of the former species were to be seen on almost every tundra pool. A set of six fresh eggs was taken on June 13. After the first of July the males disappeared and shortly afterwards broods of young were to be seen everywhere. The species was noted in fairly constant numbers as late as September 4. After this date, only solitary birds or groups of two or three were noted on the ponds. By September 29, the last had apparently left, probably for the larger waters or the sea. All males appeared to be in complete summer plumage ("eclipse," see Sutton, *Auk*, XLIX, 1932, 42-51) when we started work on May 30.

The call-note of the Old-squaw is characteristic. It is generally given by our Great Lakes shooters as "cock-a-wee," and from this one of their common vernacular names is derived. These syllables do not, however, adequately represent the call that became so familiar to us as we camped on the shores of Lake Rosabelle. The birds very distinctly said to us "owl-owl-lick" with a slight rising inflection on the "lick."

In 1931 Old-squaws were noted almost daily. Lloyd recorded the first arrivals from the south, three birds on May 21. Flocks of males seen late in May were in all stages of moult into the summer, eclipse plumage. On May 25 a flock of at least two hundred birds was seen at the river-mouth. By mid-June the females were laying eggs. Remains of a nest and six eggs destroyed by a fox (?) were found on June 24. Another nest with seven fresh eggs was found on June 30. At this time the males were still chasing the females about.

In 1932 and 1933 Twomey noted great rafts of Old-squaws on the Bay off the mouth of the river, a thousand or more, mostly males and probably the mates of the females sitting ashore. In 1932 he found great numbers on the Fox Islands, where he estimated a population of a thousand or more individuals and found about fifty nests. He found large numbers breeding also at Cape Churchill in 1933.

23. **Somateria mollissima** (Linnaeus). COMMON EIDER.

Common transient; regular summer resident; nests in suitable situations. In 1930 a few Eiders were commonly seen on the waters of the Bay, on the river near its mouth, and occasionally up-stream to near the head of tide, as late as June 18. A laying female was taken off the mouth of the river on June 19; but no other evidence of nesting in the immediate vicinity was obtained. The species has a pronounced predilection for sea islets as a nesting-ground, and there are no such islets in the immediate Churchill district. Eiders are said to nest numerously on the Fox Islands, about twenty-two miles to the east, and on Egg Island, about sixty miles northward, but see below.

In 1931 Eiders were recorded on three dates: May 30, two males and a female at the river-mouth near a great, noisy flock of Old-squaws; June 3, a female, taken by a trapper and presented to us; and June 26, a male, seen at the mouth of the river.

In 1932 Twomey, on July 7 and 8, saw from one to five thousand in the vicinity of the Fox Islands, but discovered no indication of their nesting there. According to the charts the Fox Islands are tidal islands only, at low tide being connected to the mainland by wide flats. This imperfect insularity and absence of the continuous protection from wandering land predators is probably the reason that they are not used for nesting by numerous species.

In 1933 Twomey encountered two broods, of four each, on July 7 and 8 at Cape Churchill, where the species evidently finds a more secure nesting-ground.

The northern and southern Eiders are not always very strongly differentiated. Three female specimens examined by the senior author seem to bear slightly closer resemblance to *S. m. dresseri* than to *S. m. borealis.* A single male taken at Cape Churchill on July 7, 1933, and examined by the junior author, is apparently closer to *borealis* than to *dresseri*, for the membranous processes at the base of the bill are much narrowed (averaging 9 mm. in width), comparatively pointed, and much shorter than in *dresseri*; furthermore there is practically no greenish wash on the side of the head from the region of the eye forward.

24. **Somateria spectabilis** (Linnaeus). KING EIDER.

A transient, probably commoner than our two records tend to show. A female was taken by Lloyd on September 5, 1930, at one of the ponds near Lake Rosabelle. This bird was with another Eider, and it is highly probable that both ducks were of the same species.

Twomey took a male from a flock of fifteen noted at Cape Churchill on July 6, 1933.

25. **Melanitta deglandi** (Bonaparte). WHITE-WINGED SCOTER.

Fairly common transient and summer visitor; no evidence, at present, of its nesting at Churchill.

In 1930 the White-winged Scoter was fairly common on the river from June 10 to about June 20, but it was not noted thereafter until July 22, when it began to appear again. Most birds apparently were males. A not quite mature female was taken on August 2. It is inferred from experience with the species elsewhere that these were largely non-breeding birds; or, in the case of males seen later in the season, birds that had discharged their mating duties on their inland breeding-grounds.

In 1931 two fair-sized flocks, composed apparently exclusively of males, were seen on the Bay east of the river-mouth by Lloyd and Sutton, on July 4.

In 1933 Twomey saw considerable numbers of White-winged Scoters at Cape Churchill from July 3 to 8.

26. **Melanitta perspicillata** (Linnaeus). SURF SCOTER.

A transient, irregularly common. In 1930, when the ice went out on June 10, a number of Surf Scoters appeared on the river. They were seen daily until the end of the month. After this none were certainly identified until July 31, when a flock of fifty was noted by Lloyd. No evidence of breeding was obtained.

In 1931 the species was recorded twice. On June 17 an Indian killed a handsome male along the river, and on June 26 four males were seen near the river-mouth.

In 1933 Twomey noted ten at Cape Churchill from July 3 to 8.

27. **Oidemia americana** Swainson. AMERICAN SCOTER.

A transient, irregularly common. Clarke (1890) lists an adult male taken prior to the year 1845, and Macoun (1909) records the species from Churchill.

In 1931 a flock of about thirty was seen on June 2 at the mouth of a tributary to the Churchill River, about seven miles up-stream. Later in the day, a separate pair were noted in the same region and Lloyd succeeded in taking the male.

In 1932 Twomey saw one on the townsite slough on May 29, and from one to four occasionally at the same place until July 26. He took one on June 3, which is now in the collection of the Royal Ontario Museum in Toronto. In 1933 he saw numbers of the birds at Cape Churchill from July 3 to 8.

It is not safe to infer that Scoters found summering on the sea coast indicate breeding-grounds nearby, for it is customary for males and non-breeding individuals of these species to forsake their inland nesting-grounds as soon as incubation is well under way.

28. **Lophodytes cucullatus** (Linnaeus). HOODED MERGANSER.

Scarce summer visitor; probably does not nest. In 1930 it was noted occasionally on the river near or above the rapids at Mosquito Point, from June 20 to July 27. Four specimens taken were females, and juvenal or eclipse males. We obtained no definite evidence of the nesting of the species; in fact, since there are no trees large enough to furnish suitable cavities for nesting it is unlikely that the species breeds in the immediate vicinity.

29. **Mergus serrator** Linnaeus. RED-BREASTED MERGANSER.

Common summer resident; breeds. During the summer of 1930 it was fairly common, being noted almost daily on the river. Specimens from a brood of newly hatched young were taken on August 2. The species was still present on October 4, when the records closed.

In 1931 the species was recorded many times, along the river and on the lakes. It was first seen on May 29: a pair at the mouth of a creek about seven miles up the river. On June 17 an interesting male, just moulting into eclipse plumage, was taken by Sutton at Lake Rosabelle.

In 1932 Twomey noted from fifteen hundred to two thousand on July 7 and 8 at the Fox Islands; and on June 25 he took a set of ten fresh eggs from a down-lined nest at the base of a willow clump on a high bank at the edge of Lake Isabelle, northeast of Lake Rosabelle.

In 1933 Twomey found several nests in the Churchill vicinity and observed numbers of the birds flying along the shore-line at Cape Churchill, where they passed in flocks of from twenty-five to fifty individuals every five minutes or so. He observed them also feeding amidst flocks of American Eiders.

30. **Astur atricapillus** (Wilson). American Goshawk.

Probably a scarce transient or straggler. Clarke (1890) reports an adult female taken at Churchill before the year 1845.

In 1932 Twomey saw a Goshawk at the gravel-pit on June 9. He had it under field-glass observation at one hundred yards range but could not collect it.

Since the Western Goshawk, *A. a. striatulus*, appears to be confined to the far west, these birds were almost certainly of the eastern race, *A. a. atricapillus*.

31. **Buteo borealis** (Gmelin). Red-tailed Hawk.

Probably a rare wanderer from the forested interior. Bell (1880) records the species from Fort Churchill.

In 1930 Lloyd saw two Red-tails, on August 23 and 24—probably the same individuals.

In 1933 Twomey saw an adult bird on July 12, at Goose Creek.

The subspecies represented by these individuals is entirely problematical.

32. **Buteo lagopus** (Gmelin). Rough-legged Hawk.

Regular and fairly common transient; apparently nests when lemmings are abundant. In 1930 at least three individuals were observed on June 11, beating back and forth along the steep rocks bounding Sea Horse Gully back of Button Bay. One was in the black, the others in the light phase. One of the latter, in faded yearling plumage with dark abdominal patch, was taken. We had every expectation of finding them nesting in the vicinity, but in spite of several return visits, we did not see them again. A hawk seen on July 2 was doubtfully referred to this species.

During 1931 the Rough-leg was noted several times. On May 27 two black-phased birds were seen flying eastward along the river shore, and on May 29 and 30 single birds were observed along the river. On June 3 three birds, all in light phase, were seen. On June 4 nine were seen heading eastward towards Cape Churchill. All of these were, we think, transients, for we nowhere found indication of their nesting.

In 1933 Twomey observed a considerable northwesterly migration of the species along the rock ridge near the townsite: on May 29, thirty birds passing at half-hour intervals, two or three being in view at once; on May 30, forty birds; on May 31, fifty birds; on June 1, ten birds; and on June 2, twenty birds. For several days following this period only one or two birds were seen. On June 16 ten were observed following the same northwesterly course.

In 1933 Twomey discovered three nests on cliffs overlooking water near the river-mouth. These were built of sticks, driftwood, chips, grass, and sea-weed.

33. **Aquila chrysaëtos** (Linnaeus). GOLDEN EAGLE.

Probably an occasional visitor. The junior author (1931) has already recorded a Golden Eagle taken some thirty miles inland from Cape Eskimo, about 160 miles north of Churchill. Through the courtesy of Mr. Hugh Conn, of the Hudson's Bay Company, this specimen is now in the collection of the National Museum of Canada.

On May 23, 1931, a Golden Eagle was seen clearly by Semple, Sutton, and Pettingill from the train window, in wooded country, not far south of Churchill. The bird apparently had been feeding near the railway track upon a ptarmigan.

34. **Haliaeetus leucocephalus** (Linnaeus). BALD EAGLE.

Probably an occasional visitor; may breed nearby. Preble (1902) was informed that "white-headed eagles were occasionally seen" at Churchill, and that they nested in the vicinity. He obtained in confirmation of this report the upper mandible of a bird that had been killed here.

35. **Circus hudsonius** (Linnaeus). MARSH HAWK.

Fairly common summer resident; breeds. Marsh Hawks were frequently seen throughout the summer of 1930, mostly inland but occasionally at the river-mouth or over the townsite of Churchill. About August 15 the species suddenly became more common near Fort Prince of Wales, and from three to five were seen there daily until September 5, when they disappeared.

In 1931 the species was seen frequently also, from May 28 on. On June 9 one was seen feeding on a freshly killed Pintail. On June 29 Pettingill collected a set of four eggs at Mosquito Point.

36. **Pandion haliaëtus** (Gmelin). Osprey.

Summer visitor; may nest occasionally. An Osprey was killed near the townsite by some Indians and presented to us on June 19, 1930. Another was seen at Mosquito Point on June 24, being badgered by a flock of Arctic Terns. In 1931 Sutton saw an Osprey along the river on July 3.

No direct evidence of the Osprey's breeding at Churchill was obtained, but the species probably nests up the river, as reported by Bell (1880).

37. **Falco rusticolus** Linnaeus. Gyrfalcon.

Irregular transient and winter visitant. Clarke (1890) records two specimens of "*Falco rusticolus gyrfalco*" taken prior to 1845 at Churchill, and Preble (1902) tells us that residents told him of "white hawks" they had seen. Lloyd, who spent two winters at Churchill, reports having seen white hawks in winter.

The status of the various races of Gyrfalcon in America is still in an uncertain condition. At least two races or color-forms of the species occur at Churchill, and it is probable that all American forms and phases will eventually be recorded there except perhaps the excessively dark Labrador coast type.

38. **Falco peregrinus** Tunstall. Duck Hawk.

Fairly common transient and summer resident; probably nests in suitable localities. On June 6, 1930, a Duck Hawk dashed into a flock of Bonaparte's Gulls on the townsite slough. Next day one was seen on "the point"; and on June 11 another was observed beating about the rocky bluffs overlooking Sea Horse Gully back of Button Bay. Since these bluffs were fairly high we thought we might find the birds breeding there, but we obtained no evidence that they did so, and did not observe the species again until September 30, when Lloyd noted three, probably young birds reared not far away.

In 1931 Duck Hawks were seen frequently at the mouth of the river, along the flats where the shore birds were feeding, about the construction camp and at Sea Horse Gully. The first was recorded on May 27. Semple shot a large female, with ovaries somewhat enlarged, on May 28. On June 1 two sub-adult males were taken. On June 5 and 9 young males were taken.

In 1933 Twomey observed an adult male every day or so during the last week of June and the first two weeks of July. It was always hunting along the edge of the spruce woods or over the tide-flats or tundra.

39. **Falco columbarius** Linnaeus. PIGEON HAWK.

Common summer resident; nests. In 1930 two Pigeon Hawks were seen near Mosquito Point and a high-plumaged male was taken on June 27. On July 25 an adult female and two accompanying young of the year were taken in the scrubby bush directly across the river. Later the species became more numerous, probably attracted from the spruce bush to the flats by the flocks of waders. Single birds were recorded by Lloyd on many occasions through August and as late as September 29.

In 1931 Pigeon Hawks were frequently seen. One of the employees of the Hudson's Bay Company shot an adult on April 25, preserving a photograph which we examined. On May 25 a male was seen flying rapidly along the edge of the Bay. On June 6 Pettingill collected a set of five fresh eggs and a brown-backed female at about Mile 506, not far from the railway tracks. On June 16 one attacked Semple in the woods not far from Landing Lake. On June 29 Sutton collected a pair and complete set of three eggs at Mosquito Point, the nest being in a spruce tree about twenty feet from the ground. Only one egg was fertile and this was considerably incubated. About the nest and at the base of the tree were the remains of several small birds.

The twelve specimens collected are all clearly referable to the eastern race, *F. c. columbarius.*

40. **Falco sparverius** Linnaeus. AMERICAN SPARROW HAWK.

Uncommon and irregular autumnal visitor. In 1930 it was not seen until August 19, when there appeared to be a sudden invasion from the interior. Comparatively common thereafter until September 6, from one to six individuals daily being noted on eight of the days during that period. Several were taken, all young of the year, and all referable to the eastern race, *F. s. sparverius.*

In 1931 the species was not recorded prior to July 13, when the junior author's party ceased work; but in 1932 Twomey found one dead within the townsite on July 4.

41. **Canachites canadensis** (Linnaeus). SPRUCE GROUSE.

A straggler or very rare and local permanent resident. Clarke (1890) reports a specimen taken at Churchill previous to 1845. It is reported as "rare at Fort Churchill" by Bell (1880) and there is in the National Museum of Canada a pair of feet obtained at Churchill by James Macoun in September, 1910.

On May 23, 1931, Lloyd saw a handsome male near camp at Churchill, not far from one of the buildings; it flew off to the southward. So far as any one thereabouts knew it was the first that had been seen at Churchill. On June 9, at about Mile 504, and in the deepest woodlands thereabout, Sutton found the feathers of a female which had evidently been killed by some predator.

Twomey found the remains of a male in the spruce woods near the gravel-pit on June 28, 1933.

These birds were probably of the so-called Hudsonian race, *C. c. canadensis*.

42. **Lagopus lagopus** (Linnaeus). WILLOW PTARMIGAN.

Breeds abundantly; probably irregularly common in winter. During the spring and early summer of 1930 the males, with their largely white, piebald coloring, were very conspicuous against the mossy ground. The summer plumage of the females was much farther advanced. Hidden on their well concealed nests, they were difficult to find until after they had brought off their chicks, when we met them almost everywhere. The males, unlike most male grouse, are devoted parents and were often seen in close attendance on their families. According to Lloyd's notes this species became considerably more common toward the end of August and the first week of September, when fifty to seventy-five individuals were listed on several days. Whether these comprised a fortunate number of broods encountered or the beginning of an influx of winter visitors, we do not know.

During 1931 Willow Ptarmigan were abundant. On May 18, when Lloyd first arrived, the males were noticeably whiter than the females. The first nests were found on June 9, and complete sets of eggs from June 11 on. On June 16 a female was heard to "crow" more or less like a "singing" hen. Young were first observed on July 3. After this date broods of young were to be seen everywhere.

In 1932 the species was not nearly as common as during the previous year. Twomey and Farley found twenty-five nests in 1931, while Twomey found but a single nest in 1932.

In 1933 Twomey found the species more numerous than during the preceding year and located fifteen or twenty nests.

Rather complete series of various plumages were obtained. All specimens apparently are referable to the common continental form with black primary shafts (see Taverner, 1930), now recognized by the A. O. U. "Check-List" as distinct from the European race as *L. l. albus.*

43. **Lagopus rupestris** (Gmelin). ROCK PTARMIGAN.

Apparently a winter visitor, irregularly common. Lloyd, who was stationed at Churchill for several years, saw Rock Ptarmigan every winter, but he is of the opinion that the species never occurs regularly in summer. In 1930 the only one noted was a single female in autumn plumage taken on August 19, near Fort Prince of Wales.

In 1931 Lloyd took two specimens on January 28, that are now in the Royal Ontario Museum, Toronto.

The species was rather numerous during the early part of our 1931 sojourn, being noted from May 25 to June 10. On May 26 a male in complete winter plumage was found dead near camp. On May 28 a large flock, many of them females with dark spotting, were seen at the river-mouth. Semple collected two of these in the most advanced summer plumage he could observe. On June 2 one was seen flying over camp, and on June 5 a freshly killed female was found. On June 10 one bird, probably a cripple, was seen walking among the rocks not far from the Bay.

In 1932 Twomey found a dead bird on May 24 at Lake Rosabelle, the only one seen that year.

Such specimens as are identifiable are apparently referable to the southerly, typical form, *L. r. rupestris.*

44. **Grus americana** (Linnaeus). WHOOPING CRANE.

Cooke (1914) quotes Hearne as to the occurrence of this species at Churchill in his day (*circa* 1700). In 1930 report of a large white crane with black wings killed recently by natives back from Eskimo

Point was current among the Hudson's Bay Company officials, but details concerning the specimen could not be obtained. This is undoubtedly the same Whooping Crane that Sutton (1931) records.

Eskimo Point is some 160 miles north of Churchill, but the relative geographical position of the two stations suggests the probable occurrence of the species here.

45. **Grus canadensis** (Linnaeus). Sandhill Crane.

Probably a more or less rare but regular transient; may nest occasionally.

In 1930 Sutton (1931) recorded the species at Nunalla, some seventy-five miles north of Churchill and almost at the Manitoba boundary on the Bay.

In 1931 Farley saw a gray-colored crane on June 10.

In 1932 Twomey saw one on a muskeg near Lake Rosabelle on May 29, as well as every day he visited the locality thereafter until June 7. He approached the bird within 150 yards and made definite identification. On July 15 he noted another, or the same bird, flying over Churchill.

The subspecies is almost certainly *G. c. canadensis*, the Little Brown Crane, which nests from the Arctic islands southward, for the larger Sandhill Crane, *G. c. tabida*, is a much more southern race. Specimens from Mistake Bay and northward in the National Museum of Canada and Carnegie Museum are clearly Little Brown Cranes.

46. **Porzana carolina** (Linnaeus). Sora Rail.

Rather uncommon summer resident; nests locally about the more inland lakes. In 1930 a nest full of newly hatched young was found near Landing Lake on July 15. The parents were flushed and taken before the nest was discovered. The young immediately scattered in the grass and could not be found. Gould then set mouse traps in the runways near the nest and kept circulating about until he heard the traps spring. In this way he obtained three of the brood. The next day he returned and found that the remainder of the brood had returned to the nest.

In 1931 Sutton collected a male at a little marshy pond not far from Lake Rosabelle, on June 24. The bird was calling loudly and there probably was a nest somewhere in the vicinity.

In 1932 Twomey saw a single bird.

Coturnicops noveboracensis (Gmelin). YELLOW RAIL.

Hypothetical. Probably a rare, though perhaps regular, summer visitor. Its mouse-like, secretive habits usually render its numerical status particularly difficult to determine.

In view of the fact that Preble (1902) took several Yellow Rails at York Factory, we looked for it at Churchill, but it was not until 1932 that any evidence could be obtained of its presence here. On June 20, in a grassy marsh at Goose Creek some twelve miles south of the townsite, Twomey heard some peculiar clicking notes that he ascribed to this species. He spent two hours in endeavoring to glimpse the author of the notes but had no success. The bird was within ten feet many times, but it refused to flush even when rushed. If Twomey sat still for five minutes or so the notes would start up again and gradually approach until they seemed within hand's reach, but never could a sight of the bird be obtained. All this behavior is in accord with familiar accounts of the Yellow Rail, and it is so unlike that of any other species that Twomey's assumed identification seems justified.

47. **Charadrius semipalmatus** Bonaparte. SEMIPALMATED PLOVER.

Very common transient and summer resident; nests abundantly. In 1930 it was present on the date of our arrival, May 26, and was considered, throughout the summer, a very abundant wader. It nested on bare ground, or less frequently on the moss of the tundra. It was common until August 27, when most of the birds left, but a few stragglers remained until September 16.

In 1931 Lloyd saw the first spring individual about May 20. On May 25 he saw two not far from "town." Many nests were found during the course of the spring and summer.

48. **Oxyechus vociferus** (Linnaeus). KILLDEER.

Uncommon although regular summer resident; nests locally.

In 1930 a pair or two were seen off and on about the townsite slough and a downy young was taken there. This specimen was so dark and grimy with soot from the construction works and engines as to be specifically almost unrecognizable. The species was not noted after August 30.

During 1931 Killdeers were seen about town from May 26 on, and two pairs were thought to have nested in the vicinity. On June 10 a female that was building her nest was collected. All the birds were very dirty as a result of the smoke from the camp.

49. **Pluvialis dominica** (Müller). AMERICAN GOLDEN PLOVER.

Common transient and summer resident; nests. In 1930 it was first noted on June 4, and a few were in evidence almost daily thereafter. Nests were found with fresh eggs on June 14 and with newly hatched young on July 14. The first was on a small knoll in the middle of the low tundra, the surrounding moss being still wet with spring surface water. The other was in the moss between half-buried boulders on higher dry ground. Neither was within half a mile of permanent water. Toward the end of August and the first of September there was a slight increase in the numbers of Golden Plover, and small groups or flocks, instead of isolated single individuals, were noted. These probably were arriving migrants. The last was noted on September 16. No partly grown young were seen and the notes available do not show how much time elapsed between the departure of the juveniles and that of the adults.

In 1931 Golden Plovers were recorded flying over camp on May 29 and 31, and on June 2 a male was taken. On June 17 Sutton collected a set of four fresh eggs with the incubating male, the female not being seen. On July 1 three nests were found by Semple, Lloyd, and Sutton and a pair were collected. No downy young were taken. The birds were rather quiet about their nests and the discovery of nesting pairs always came as a surprise. The principal nesting-ground was the open tundra just inland from the Bay between the coast and the belt of stunted spruce trees. Specimens taken are referable to the eastern race, *P. d. dominica.*

50. **Squatarola squatarola** (Linnaeus). BLACK-BELLIED PLOVER.

Uncommon transient. A single bird was noted on June 10, 1930, but the species did not appear again until July 25, when five adults were seen, and one in full summer plumage with little sign of plumage change was taken. On August 2 a small flock was noted near Mosquito Point. On August 19 an adult about half changed to winter plumage was secured. The largest flight occurred on September 29, but the species was occasionally noted as late as October 4, when the records closed.

In 1931 the species was seen several times, but it was never common and gave no indication of nesting. It was first recorded on June 1, and two were seen the next day. A male was taken by Lloyd on June

6. On June 8 a flock of about forty was seen. On June 12 another large flock was seen and a dull-colored female collected. The species was last recorded on June 18.

In 1933 Twomey saw several flocks of from ten to twenty birds on June 10, and a single adult male that remained until June 28.

51. **Arenaria interpres** (Linnaeus). TURNSTONE.

Regular transient. In 1930 it was noted from May 27 to June 14 and from July 22 to September 25. On first arrival in spring the birds frequented the garbage dump of the construction camp at the edge of the sea ice. It was unexpected and novel to see these gaily colored waders contentedly picking their way about the white snow and ice masses.

In 1931 Turnstones were seen from May 29 (two recorded) to June 29, when one was detected along the edge of the river searching for food among old tin cans. Several specimens were taken. A pronounced migratory movement was noted on the evening of June 9, when many noisy flocks continued to fly over camp, high in the air, evidently headed for distant parts to the north.

In 1932 Twomey saw the species commonly from May 29 to June 9. The first autumnal migrants were two noted on July 18; on July 26 a flock of about two hundred was noted.

In 1933 Twomey found Turnstones very plentiful at the time of his arrival on June 5. A number lingered for some time, indulging in courting ritual and mating songs until there was some expectation that at least two pairs might nest. All suddenly disappeared, however, about mid-June.

52. **Capella delicata** (Ord). WILSON'S SNIPE.

Fairly common summer resident; nests. In 1930 it was tolerably common on the muskegs adjacent to timber, where it was often heard high overhead whinnying in its spring flight. Gould took young, able to fly, but with stubby tails and down still adherent to the head, on July 18, 20, and 25. On these dates no adults were in evidence and it appears that as in the case of certain other waders the adults leave for the south just as soon as the young can fend for themselves. Neither young nor old birds were noted after July 25.

In 1931 Twomey took downy young on July 12.

53. **Phaeopus hudsonicus** (Latham). HUDSONIAN CURLEW.

Common transient and summer resident; nests. Because of its size and noisy reaction to intrusion it is one of the most conspicuous birds of the lower lying tundra. In 1930 it was common by May 31, and it remained so until September 7, when it suddenly left, only a single individual (September 12) being observed thereafter. The largest numbers, probably augmented by transients, were recorded during the third week in August. Fresh eggs were found on June 13 and 14 and moderately incubated sets on June 14 and 21. Newly hatched young from two broods were taken on July 11.

In the vicinity of their nest these curlews are noisy and agitated, spying the intruder from afar on the open tundra, both birds of a pair, and sometimes adjacent neighbors, flying to meet him, protesting vigorously, beating away in great circles, returning in long dives that glide upward just short of actual attack, and then making off for a repeat. For a time they may mount some distant hummock or small tree-top from which to watch and tell the world of the unparalleled danger that threatens the community.

Though we found several broods of newly hatched young, we failed completely in locating partly grown birds. Once well on their legs the young are good runners and hiders and are too well warned by their vigilant parents to be surprised in exposed positions. The most patient waiting in the all too slight cover that was available failed to restore enough confidence to the agitated old birds to induce them to betray the location of their ganglings. Young birds were taken on August 19, but these were already fully fledged and practically ready for migration.

This is the first definite evidence that this species breeds east of the Anderson River region, Mackenzie,[2] and since the downy young seems not to have been previously known, we present herewith a description of the plumage, which is also illustrated in color in the frontispiece.

Ground-color about pale olive-buff,[3] whitening on the abdomen, breast, and foreneck, and warming towards clay-color on face and hindneck. On this many rather indefinite spots and broad, broken stripes of dark brown, or nearly black, on back, thighs, and in front of wings.

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[2] The junior author found the species in midsummer on Southampton Island, but neither eggs nor downy young were actually collected.

[3] The names of colors are from Ridgway's "Color Standards and Color Nomenclature," 1912, Plates XL and XXIX.

A similarly black bar running back from eye towards nape, a fine line from bill to eye and a broader one up forehead, succeeded by two broad crown-stripes. Bill blackish, slightly fleshy towards base. Legs and feet dull lead-color.

In 1931 the Hudsonian Curlew was first recorded on May 28, when two birds flew over camp. The species became common thereafter. Several were collected on June 2. During latter June many nesting pairs were located. Pettingill took a set of four eggs on June 24. Other nests were found on June 29 and July 1.

Several nests were found by Twomey and Miss Heydweiller in 1933, and Twomey is of the opinion that the species was more abundant this season than during the two preceding years.

Phaeopus borealis (Forster). ESKIMO CURLEW.

Hypothetical. Probably formerly a common transient, and perhaps a regular summer resident; now extirpated and practically if not actually extinct. This Curlew has been confused in literature with the Hudsonian and its former distribution is now difficult to determine. Its only known former breeding-ground is the Anderson River region of the northwest Arctic coast, but it may well have extended eastward to Hudson Bay and the Churchill neighborhood. Bell (1880) lists the Eskimo Curlew as well as the Hudsonian as common at Churchill in July and August. This statement is not out of harmony with past conditions as we know them.

In 1930 Gould saw four very small curlews in a flock of larger Hudsonians on July 10. He watched them in close association through glasses under good observational conditions and is confident that they were of this species. They did not permit of close approach and could not be collected. That the small ones flew with the rest lessens the possibility that they might have been partly grown youngsters of the larger species. In 1933 Twomey had a similar experience with a flock of large and small curlews, and coincidently on the same date, July 10. He watched them for some minutes with field glasses but like Gould was unable to confirm his impression of Eskimo Curlew by taking specimens. It would be a matter for congratulation if it could be proved that the Eskimo Curlew is still extant, but with our present knowledge it does not seem that any sight record can accord the species more than hypothetical status.

Bartramia longicauda (Bechstein). UPLAND PLOVER.

Hypothetical. Preble (1902) met the Upland Plover south of Cape Eskimo. Though we did not see it in either 1930 or 1931, it eventually will probably be noted.

54. **Actitis macularia** (Linnaeus). SPOTTED SANDPIPER.

Rather rare and local summer resident; nests. In 1930 a pair nested on the gravelly edge of the river at Mosquito Point, and a solitary bird was seen throughout the summer on the townsite slough. The species is probably more common up the river.

In 1931 it was noted several times about the ponds at the edge of town and at Mosquito Point. One was collected on June 16. On June 17 two were seen. On June 24 many were seen and heard. It appears from these data that this species may slowly be establishing itself at the mouth of the Churchill River.

55. **Tringa solitaria** Wilson. SOLITARY SANDPIPER.

Summer resident; breeds regularly and probably in considerable numbers. In 1930 Gould took Solitary Sandpipers on July 18 (a single male) and on July 25 (two or three seen). These were all apparently without mates, though the male taken July 18 protested strongly and may have had young nearby. No other sign of breeding was observed.

In 1931 the species was first noted on June 4, when a male was collected from a water-filled rut along one of the roads in the spruce woods. On June 8 a female with an egg almost ready for laying was taken from a shallow woodland pool. A male was seen at the same place, but neither bird was agitated at our approach or acted as if the nest were close by. During mid-June we several times saw Solitary Sandpipers giving display flights high in air. On June 11 remains of two birds were found in the grass at the edge of the woods, victims perhaps of a Short-eared Owl, Marsh Hawk, or Pigeon Hawk. On June 16 a female with a pronounced brooding-patch was collected. Twomey took one and two specimens on July 5 and 12 respectively. There can be no doubt that the species was breeding somewhat commonly in the suitable woodlands.

The six birds collected are all adults; in all of them the spotting of the back is white without a trace of cinnamon; the primaries are more or less mottled; measurements, particularly of the wing, are large for the species; and they are therefore clearly referable to the western race, *T. s. cinnamomea.*

The distinctive characters of this race are:

1. Outer primaries more or less mottled or marbled with whitish, a character not altogether constant but conclusive when present.
2. Wing averaging longer than in the eastern race, but with some overlapping between the two forms.
3. Back-spotting cinnamon in the young of the year, but white and inseparable from that of the Eastern Solitary in the adult.

The wing measurements[4] of the six specimens taken are: males 5.23, 5.00, and 5.25 in. (133, 127 and 134 mm.); females 5.35, 5.37, and 5.36 in. (135, 137, and 136 mm.).

The breeding of the Western Solitary Sandpiper as far east as Churchill is of more than passing interest. The only nestings of the species heretofore actually demonstrated have been in western Alberta and central Saskatchewan, and these birds are definitely referable to the eastern race, *T. s. solitaria*. Birds taken in eastern Alaska and adjoining Yukon Territory, and presumed to be nesting, are the western form, *T. s. cinnamomea*. The two races migrate through British Columbia and western Alberta, and (with the Western in gradually lessening numbers) east occasionally to Manitoba. With the evidence now at hand it appears that *cinnamomea* may be a northern race, breeding from Hudson Bay west to Alaska, rather than, as has been supposed, a western one.

With this new light on the summer distribution of the two forms it may be well to call attention to the necessity for very careful identification of Solitary Sandpipers during the period of migration. The chances are that some of the birds found in spring and fall in regions directly south of Hudson Bay are *cinnamomea* rather than *solitaria*.

56. **Catoptrophorus semipalmatus** (Gmelin). WILLET.

On June 2, 1931, Sutton collected a well-plumaged male from a flock of shore birds feeding at high tide along the river about five miles from its mouth. The specimen proves to be referable to the western race, *C. s. inornatus*.

57. **Totanus melanoleucus** (Gmelin). GREATER YELLOW-LEGS.

A transient, more common in autumn than in spring. Though Preble (1902) considers the Greater Yellow-legs as common from Churchill to Cape Eskimo in August, the species was not seen in 1930 until August 2, when two adults in worn, very heavily marked plumage were taken near Mosquito Point. On August 15 two more were obtained, one in nearly complete winter plumage. The species was noted in small but fairly regular numbers through the latter half of August and the first week of September, after which but occasional birds were seen; it was last recorded on September 30. It was never as common as the Lesser Yellow-legs and there were no indications of its breeding.

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[4] The junior author wishes to acknowledge the assistance of Mr. W. E. Clyde Todd of the Carnegie Museum, in securing measurements of several specimens taken in 1931.

In 1931 the species was observed but once, on May 25, when one was heard "yammering" loudly at the townsite slough.

58. **Totanus flavipes** (Gmelin). LESSER YELLOW-LEGS.

Common summer resident; nests on the more open muskegs in the forested country. In 1930 it was not seen until June 6, but thereafter it became common, even to the point of being a common nuisance, as its loud protestations and wild dashes on the appearance of an intruder put all the birds of the vicinity on the *qui vive* and spoiled many a quiet approach. Fresh and slightly incubated sets of eggs were taken on June 25. On July 16 young showing the first intrusion of new body plumage among the down were obtained, and on July 10 and 18 half grown birds were taken. As late as July 28 old birds were still giving loud protest, alighting in trees and scolding as if yet with young, when most of the other waders were freeing themselves from family responsibilities. They remained in fairly constant numbers until August 26, and three were observed September 3.

In 1931 the species first appeared on May 27, when two birds were seen and courtship activity was noted. From this date on, it was noted every day.

59. **Calidris canutus** (Linnaeus). KNOT.

A transient, regular in the spring, not recorded in the fall. In 1930 Knots were taken on June 2 and 12, on the latter date a male still half in winter plumage. None were noted thereafter.

In 1931 three Knots were seen by Lloyd and Sutton on June 12, about seven miles up-river. A male in almost complete breeding plumage, but with an injured leg, was taken by Lloyd.

Specimens taken are presumably of the American race, *C. c. rufus*.

60. **Pisobia melanotos** (Vieillot). PECTORAL SANDPIPER.

A transient, more common in autumn than in spring. In 1930 no Pectoral Sandpipers were seen in spring. The first were noted on July 6, these being adult birds and apparently transients. From July 12 on they appeared in some force, but all taken prior to August 1 were adults. On this date the first juvenile was secured. The species remained until August 14 in reduced but constant numbers. It was seen in smaller numbers as late as September 16, with one flock of thirty-five noted on September 3.

During the spring of 1931, however, the species was recorded three times. On May 27 Sutton collected a solitary female along the tidal flats of the river, and on June 1 he took another single female in almost the same place. On June 2 an individual was noted in a flock of White-rumped Sandpipers.

In 1932 Twomey noted one on June 21, four on July 4, and about two hundred on July 15.

In 1933 Twomey found transient individuals common in the grass along the tidal flats for the first two weeks of June, and noted even larger numbers of the birds during the middle of July.

61. **Pisobia fuscicollis** (Vieillot). WHITE-RUMPED SANDPIPER.

Common transient. In 1930 White-rumps were common in migration, but none summered and there was no indication of their breeding. A few were noted on the townsite slough at the time of our arrival, May 28. By May 31 they were abundant there, remaining in constant numbers until the ice went out of the river on June 10, when most of them left. None were noted after June 14. The first southward migration was noted on July 27, when two adults were taken, one in almost complete winter plumage, the other in old, worn plumage just beginning to change. The species was not seen thereafter until August 17. A few were noted daily until August 23.

It is perhaps a coincidence that in 1931 the species was not noted until May 28, when two were observed and one collected along the tidal flats of the river. Large flocks did not arrive until June 1, and the great wave of migration passed about June 19. On June 21 and 22 single individuals were seen. In some of the specimens taken the gonads were somewhat enlarged but no other sign of breeding activity was noted.

In 1932 Twomey recorded fifty on May 29; observed that the species became steadily commoner thereafter; saw three hundred on June 4; and noted the last on June 8. The first southward moving transients he saw on July 23: two birds. On July 26 he noted twenty.

In 1933 Twomey found it abundant in early June and again in latter July.

62. **Pisobia bairdi** (Coues). BAIRD'S SANDPIPER.

Not very common transient. In 1930 only a few were noted in the spring—two to four daily between May 31 and June 1. The first of the fall migrants appear to have arrived on August 6, when three adults and one juvenile were collected. Fall adults are rare enough in collections to make these of more than passing interest. The adults usually pass through or over the more settled districts without being detected and it is only the juveniles that linger and are observed in the autumn. Juveniles alone were collected as late as August 20, and all had left by August 25.

In 1931 the species was similarly uncommon, though several specimens were taken. It was first noted on June 1, when a female, one of three birds, was taken. On June 2 several were seen among flocks of other shore birds. The species was rather numerous on June 5. Thereafter only single birds were noted on June 10, 12, 18, and 19. Baird's Sandpipers were usually seen along the gravelly margins of the upland pools rather than along the tidal flats. They were very quiet as a rule, and their clay-colored backs rendered them very inconspicuous.

In 1932 Twomey saw one on May 29; ten on June 4; and four on June 7. Four autumnal migrants were seen on July 18. The species became common thereafter.

63. **Pisobia minutilla** (Vieillot). LEAST SANDPIPER.

Summer resident; nests abundantly. It is uncertain how much farther north this species goes. It is not a far northern breeder like the Semipalmated Sandpiper, though it has been confused with this species often enough to raise doubt as to the authenticity of many of the more northern records that are to be found in the literature. On present evidence we think it probable that the nesting-range of the Least Sandpiper does not regularly extend to the north much beyond the tree-line.

In 1930 it was present at the time of our arrival on May 28, and remained in fairly constant numbers without marked influx of migrants until August 8, when it suddenly disappeared.

In 1931 it first appeared on May 27, when two males were collected. On the following day many were noted and both sexes collected. On May 31 a pair were seen mating near the camp-site, and on June 2 a nest ready for eggs was found. The first full set was recorded on June 11; thereafter many nests were found. So far as could be determined this species and the Semipalmated Sandpiper nested in precisely the same sort of place, so it was not always easy to identify the eggs satisfactorily.

64. **Pelidna alpina** (Linnaeus). DUNLIN.

Abundant transient and common summer resident; nests. In 1930 the American Dunlin or Red-backed Sandpiper, the form of the species accredited to the New World, was fairly common all summer. The first one appeared on May 29, and by June 2 they were common on the townsite slough. About June 6 they practically deserted this locality and were found back from the tidal flats, scattered over the lower tundra, which was still wet with melting snow. Nests with fresh eggs were taken on July 12. Later, when we began special search for downy young, we had a difficult time. There were always a few adults on the low ground near the tide-flats, but even with the most persistent watching we failed to discover the young. The old birds in our presence sat about on boulder tops, phlegmatically watching, moving from rock to rock, not going far away, but with a remarkable patience and unconcern that outdid all our efforts at finding their progeny. We finally decided that these were birds on relief and that the young were some distance away on higher ground. One downy young with wing-quills just beginning to show was taken by Gould on July 15.

By July 23 three-quarter fledged young were comparatively easy to find. Many in this stage were observed on July 28, when the old birds began to disappear, leaving their young, barely able to make short flights, with stubby tails and down still on their heads, to fend for themselves. The young moult from the down into a distinct juvenal plumage, quite different from any plumage that is seen farther south on migration, in which the back feathers have a strong rufous edging. Across the breast and foreneck there is a wash of light buff that weathers rapidly to light dusky; this area is finely striped with blackish, much as in the Pectoral Sandpiper. The flanks are more or less heavily marked with soft black flecking. This plumage is definitely shed for the usual soft gray and white winter plumage before the autumnal migration is commenced.

Juvenile Red-backed Sandpipers remained in fairly constant numbers until August 20, when they disappeared. It is a matter of much speculation where these birds, the adults that leave Churchill the end of July and the juveniles that disappear the end of August, in summer and juvenal plumage respectively, spend the time until their much later appearance on migration in well-advanced winter coats in southern Canada.

In 1931 Red-backs were first noted on May 25, along the tidal flats of the river. By May 28 they had become common. On May 30 isolated pairs and migrant flocks were noted, the former back on the tundra, the latter along the flats with other shore birds. The first complete set of eggs was noted on June 16, and thereafter many nests were found, most of them in tussocks of grass in marshy places. On June 30 a nest with almost fresh eggs was found and downy young probably not more than two days old were collected. Incubating birds which were collected proved with one exception to be males.

Twomey informs us that five birds collected from their nests in 1932, and six birds similarly taken in 1933, *all* were males. According to this statement, to experience during 1931, and to the junior author's (1932) experience at Southampton Island, the male Red-backed Sandpiper must assume a large share of the duties of incubation.

65. **Limnodromus griseus** (Gmelin). Dowitcher.

Transient, common in autumn; rare and local summer resident; breeds sparingly. In 1930 single birds and pairs were taken along the river just above Mosquito Point during the latter half of June. On July 18 an adult was taken in the vicinity of Landing Lake, and on June 20 juveniles able to fly, but with down still adherent to the head, appeared, corroborating our suspicion that the species had bred locally. This is the first verified breeding record of any Dowitcher east of the Anderson River and central Alberta. Beginning with the first of August the species was seen almost daily, but all birds appeared to be juveniles. About sixty were seen on the tidal flats on August 8, when the bulk of the migration passed. None were observed after August 20. Juveniles of the year all have striking rusty feather-edging on the back, and none of them show any trace of the incoming gray winter plumage.

During 1931 the species arrived in early June, a female being taken by Pettingill at the edge of the spruce woodland on June 2. On June 13 a female was collected at the edge of a little gravel islet in the river about seven miles up-stream. A male with noticeable brooding-patches was taken at the townsite slough on June 18, and on June 20 a male and female were taken at Landing Lake. On July 1 a pair, evidently with young, scolded us as we went through the woods. Twomey informs us that he took six specimens at Goose Creek during the season of 1931.

In 1932 Twomey saw the species frequently during June and July about the townsite slough. At Landing Lake he watched four pairs from the middle of June to the first week in July. These birds appeared to be breeding, but no nest was found. On June 5 he collected a female with a completely formed and colored egg in the oviduct.

Specimens examined have consistently short bills, those of four adult males running from 55 to 59 mm., and of three females from 58 to 64 mm. The breasts are rather pale and much spotted. The high extreme for the bill of *L. g. griseus* and the low extreme for that of *L. g. scolopaceus* is quite consistently 60 mm. for the male and 65 mm. for the female. It is evident therefore that these birds are short-billed, as in the eastern *L. g. griseus*. It is to be noted that the specimens taken in 1930 formed part of the material examined by Rowan (*Auk*, XLIX, 1932, 14-35) in his establishment of the new race, the Inland Dowitcher, *L. g. hendersoni*, and are included by him under that name. Material is not at hand to confirm all his conclusions as to the differences of this new form from *L. g. griseus*, but from the specimens available we are inclined to accept *hendersoni* as a valid subspecies.

66. **Micropalama himantopus** (Bonaparte). STILT SANDPIPER.

One of the commonest of the breeding shore birds. In 1930 a few were noted on the Churchill slough on May 28. By June 2 they were numerous. After June 6 they thinned out on the slough and scattered over the tundra. The first nest was found June 17. Other nests were found thereafter. Later in the season many young were seen and specimens were taken in various stages from downy young to almost mature birds. The adults left about July 17, before there was any marked incoming of winter plumage and while the young were still quite undeveloped. After all the adults had disappeared many young that could scarcely fly, and with considerable down still about the head, remained for quite a while. The record indicates no particular influx of transients. The species was last seen about August 23.

In 1931 the species arrived May 26, when several were seen on the townsite slough. The following day fully twice as many birds were noted, though the tundra was covered with snow and only a few of the ponds were thawed. On May 28 a mated pair was observed, though as late as June 4 flocks were noted along the river-bank. On this date a male still in almost complete winter plumage was taken. On June 10 the first eggs were recorded and on June 15 the first complete set. On June 18, during a severe blizzard, most of the shore birds deserted their nests and many pairs of Stilt Sandpipers were seen standing disconsolately about the slough. The first young birds were seen on June 30. On July 3 a brood of young were found on the railroad track just after a freight train had passed over. The young could not surmount the rails.

67. **Ereunetes pusillus** (Linnaeus). Semipalmated Sandpiper.

Abundant transient and summer resident; breeds commonly, but the nest is sometimes a little harder to find than that of the Least Sandpiper, as the Semipalmated is a rather wilder and less confiding bird. In 1930 the species was already present and common by May 28, remaining so until about July 23, when it began to thin out. By July 28 it was almost scarce on the tundra. On the tidal flats it became common again during the first three days of August, then less common until August 28, when it nearly disappeared, though individuals of somewhat doubtful identification were noted through September.

The Semipalmated Sandpiper has a rather attractive little song that is given both on the ground and in the air; a repeated "*ree-ree-ree-ree*" continued for a considerable fraction of a minute with little variation. The bird circles about in the air singing this little tinkling ditty, and when mating is in full swing the air is so full of it that it is unusual for even a few minutes to pass without its being heard. One hearer likened the *ensemble* of many voices to the distant chattering of a mowing machine; to another it resembled the chorus that arises from the meadow pools when spring peepers are going strong.

In 1931 the species arrived on May 26, when one bird was seen in company with a flock of Stilt Sandpipers. On the following day three were noted and by May 29 the species was common everywhere. The first eggs (two) were noted on June 14, and the first full set on June 17. The males incubated fully as much as did the females.

68. **Tryngites subruficollis** (Vieillot). BUFF-BREASTED SANDPIPER.

Uncommon transient. In 1930 the first Buff-breasted Sandpiper was observed on July 22, when a flock of twenty was noted near the river-edge opposite the Lake Rosabelle camp. The species was seen or taken several times from August 1 to 21. All specimens collected prior to August 3, and one taken on August 17, were adults in worn breeding or part winter plumage. In these the relict plumage is much like that of the juvenal, showing many fine white semicircles on the back, but unlike the juvenal, the effect is obtained by wear and fading, the former cutting the broad feather-edges down to fine pencil lines and the latter bleaching them from warm buff to white. The incoming plumage is broadly and softly edged with warm buff as in the spring plumage.

In 1931 the species was not observed.

In 1932 Twomey saw five on July 24 and ten on June 25, all on the high ridge along the pipe-line from Lake Rosabelle to the townsite. Specimens were collected on both days.

69. **Limosa haemastica** (Linnaeus). HUDSONIAN GODWIT.

Finding this species breeding at Churchill was one of the interesting attainments of 1930, as the only nesting-localities previously known were the Anderson River and the mouth of the Mackenzie River. A pair were noted on the Churchill slough on May 29 and 31, and what may have been the same birds were taken on June 4. The female of these two was found to have well developed eggs in the ovaries, one, lacking only the shell, probably being ready for deposition the next day. No other Godwits were seen until Gould noted a single bird near Landing Lake on July 20. On July 25 half a dozen or more were seen on the river-flats opposite to Mosquito Point. Three were taken, all adults, and one just beginning to change to winter plumage. On August 2 two more were taken in the same general neighborhood, one just beginning to moult, the other in almost complete winter plumage. On August 11 and 14 several juveniles in full first winter plumage were taken near Fort Prince of Wales. These differ from adults in winter plumage in having the back feathers heavily edged with rusty ochre.

In 1931 the species was not noted until May 29, when two handsome adults were seen along the eastern shore of the river about six miles from its mouth. On June 2 two were seen, and on June 12 four were collected out of six seen. The call-notes heard on this date might be written "*too-it.*" The birds were not particularly wary. On July 1 one was seen flying high in the air, calling loudly as if in courtship display, and Pettingill encountered in a wooded muskeg two pairs which behaved much as if they had eggs or young. On June 3 eleven birds were seen along the banks of the river, not in country where the species was thought to be nesting, and a male and female were collected.

The species probably nests in scattered pairs back in the muskeg country, coming out to the river-flats as soon as the young are nearly grown and thereupon leaving almost immediately for the south. The young follow to the shore as soon as they are fairly well fledged and migrate after their elders have departed.

It was noted during both 1930 and 1931 that after the courting season the orange color of the base of the bill in the male faded rapidly to dull fleshy. In field sketches made by the junior author from freshly killed specimens the base of the bill in the courting male is clear, rather bright orange; in females taken at the same time the base of the bill is purplish flesh-color of a distinctly different appearance. Fading of the bill in the male brings it to a color approximately that of the female's. In 1930 all specimens collected after June had dull, flesh-colored bills.

In 1932 Twomey saw only a single individual at Landing Lake on June 5.

70. **Crocethia alba** (Pallas). SANDERLING.

A transient, usually commoner in fall than in spring. In the spring of 1930 it was noted only once, when two were collected on June 4 at the garbage piles on the edge of the bay ice. In the fall single birds were observed on August 6 and 7, and on August 10 four adults changing into winter plumage were taken. The species remained fairly constantly common until August 24, when all disappeared.

In 1931 the species was observed many more times in the spring than in the previous year. It was first noted on June 2, when two were seen. On June 4 a male was taken on the Churchill slough. On June 5 a male and female, and on June 10 three females were collected. On June 12 at least six birds were noted and one male was collected. On June 16 ten were seen in a loose flock along the bank of the river, and on June 19 a male and female were taken.

71. **Phalaropus fulicarius** (Linnaeus). RED PHALAROPE.

Rare transient; may breed locally. Though Preble (1902) found the Red Phalarope feeding young apparently in the neighborhood of what is now Nunalla, some seventy-five miles north, the species does not occur more than casually at Churchill at the present time, and does not normally nest here. Clarke (1890) lists a pair in breeding plumage from Churchill taken prior to 1845.

In 1930 only a single individual was noted; this was taken on August 9, near Fort Prince of Wales.

In 1931 the species was seen several times but no evidence of nesting was obtained. Sutton took a male in breeding plumage along the river about six miles from its mouth on June 2, and a pair were noted next day at the river-mouth by Mr. James Spence of the Hudson's Bay Company. Farley took a specimen on June 11, and Lloyd one on June 12. A male taken by Semple on June 17 had enlarged gonads.

In 1932 Twomey took from a deserted and unidentified nest a set of eggs that agree so closely with those of this species as to suggest the possibility of its occasionally breeding here.

In 1933 Twomey noted larger numbers of Red Phalaropes than in the two preceding seasons, counting twenty-five at one time about a small lake.

72. **Lobipes lobatus** (Linnaeus). NORTHERN PHALAROPE.

Common transient and summer resident; breeds abundantly. In 1930 it was present at the time of our arrival, May 28, and remained common until the middle of August, when the bulk of the species disappeared. The last was noted on August 18.

Through the summer no pond, lakelet or pool was complete without one to several of these graceful little birds disporting themselves and cutting graceful circles on its placid surface. Notwithstanding their omnipresence and the obviousness that they were breeding commonly, no nests were discovered. Both males and females acted as if much disturbed at our presence, but in spite of our continued watching, none ever led us to a nest. Incubating birds flushed far ahead of us and refused to return until we had departed. By July 11 many young were abroad; and by July 28 nearly full-fledged juveniles were common. About July 25 the adults began to disappear from the nesting-grounds, leaving the young, still carrying traces of down about their backs, and flying but little, to shift for themselves. So far as we know, none of the adults had begun to change to winter plumage before they left. The last one taken, a male (July 31) shows no sign of moult. Early autumn migrant specimens of corresponding date (July 28) in collections from southern Manitoba are already consistently well-advanced in change to winter plumage, and are probably non-breeding birds moulting in advance of their nesting brethren. It may be surmised that the breeding birds, leaving the nesting-grounds at the earliest possible moment the young can fare without them, undergo the greater part of their summer moult at sea, where, at this season of the year, large flocks are often encountered by the voyager.

Similar migrational conditions exist in most of the waders. Throughout our more southern regions the autumnal wader migration opens very early, obviously before many of the parent birds can be through with their nesting-duties. These early arrivals generally are adults that hasten through and are quickly gone. They are few in number and do not form any notable portion of the adult population. Many of them are advanced in moult, which is not regularly begun until after reproductive responsibilities are discharged. They probably comprise the non-breeding or the unsuccessful breeding element, leaving the summering grounds early and not rushing through with the breathless haste of the bulk of older birds, that pass without being observed. Later, when the great hordes of migrants arrive, they are found, almost without exception, to be young of the year moving south in a leisurely fashion and lingering on the way.

In 1931 the Northern Phalarope was first noted on May 29, when two females were seen about six miles up the river. On May 30 a solitary female was shot on the townsite slough and two other females were observed flying about the open water at the mouth of the river. On June 1 many birds, both males and females, were seen. A nest containing one egg was found by Twomey on June 18, and the first complete set was collected on June 21. Thereafter many nests were found. Downy young were first noted on July 15.

73. **Stercorarius pomarinus** (Temminck). Pomarine Jaeger.

Though Preble (1902) saw several Pomarine Jaegers near the mouth of the river on July 21, and though Clarke (1890) records an adult from Churchill taken previous to 1845, our only note on the species is of a sight record made by Gould on June 30, 1930.

74. **Stercorarius parasiticus** (Linnaeus). PARASITIC JAEGER.

Common summer visitor; nests occasionally. In 1930 it was very common all summer off the mouth of the river, where a number were always to be seen occupying Merry Rocks (off the townsite point), or harrying the Arctic Terns. Espying a tern carrying food, they would swoop at it again and again, often two working as a team, one driving to the other. The tern would dodge this way or that, endeavoring to escape by speed or agility, but usually without avail. To rid itself of its tormentors it would finally drop the fish, which one of the jaegers dexterously caught before it reached the water. The stoops and strikes at the smaller tern were so vicious and determined, and the tern apparently so helpless, that we often wondered whether the robbers were not as much interested in devouring the bird as the fish it carried. However in every case observed the jaegers seemed satisfied with the tribute exacted and gave up pursuit when this was obtained. A few jaegers often wandered up-river and over the higher tundra. In every case they devoted their attention to the terns and we never saw them chasing any of the small waders or longspurs that abounded everywhere.[5]

All Parasitic Jaegers seen during 1930 were in light phase. The darkest were two taken on July 30. These are barred with dark below, but do not approach the usual dark phase. The legs and feet of all others taken are solid black, but in these they are irregularly splotched with bluish gray. It is assumed that they are birds of the previous year. In the collection of the National Museum of Canada are Parasitic Jaeger juveniles of the year with tarsi and exposed tibiae light blue and webs clear pink at the base. It appears that the juvenile of the light phase is more or less barred below, with blue tarsi and pink webs, changing with age to purer white below, and to black legs and feet. This change is not complete by the first part of the second summer.

The species remained fairly common through August and the first days of September, after which but a single individual was noted, on September 13. Lloyd says that he had reason to believe a pair had bred near the townsite the previous summer.

[5] This observation is at considerable variance with that of the junior author (1932) at Southampton Island, where the Parasitic Jaeger was found to be a constant enemy of all small birds—Snow Buntings, Lapland Longspurs, Horned Larks, and shore birds.

In the spring of 1931 the species was noted nearly every day, first on May 28, when two birds were seen flying along the coast of the Bay about four miles east of the river-mouth. Single birds were usually seen. On June 25 a single bird in the black phase was observed for some time at the river-mouth. On July 1 Twomey found a nest, containing one egg, in the muskeg country not far from Landing Lake.

In 1932 Twomey found a nest with two eggs near Landing Lake on June 23.

In 1933 "several" nests were found by Farley and Twomey.

75. **Stercorarius longicaudus** Vieillot. LONG-TAILED JAEGER.

Preble (1902) reports a specimen of Long-tailed Jaeger from Churchill in the United States National Museum. The species was not observed in 1930. On May 29, 1931, five were seen at the mouth of a small tributary to the river, about seven miles up-stream. They were flying with, but not chasing, the Bonaparte's Gulls. One specimen was taken. One was noted on June 2, and another taken on June 4, at the river-mouth. Single birds were noted also on June 8, 11, and 16. Between June 23 and July 2 Twomey took five specimens, that are now in the Royal Ontario Museum of Zoology, at Toronto.

In 1932 Twomey took one on June 23. On June 24 he saw thirty sitting on the ice-floe off the Merry Rocks at the mouth of the river. These remained until July 4, leaving when the ice moved out to sea.

76. **Larus hyperboreus** Gunnerus. GLAUCOUS GULL.

A transient, fairly common in spring and late fall. During May and June of both 1930 and 1931 a few Glaucous Gulls were commonly seen among the flocks of Herring Gulls that frequented the garbage dumps on the ice near the townsite or hung about the mouth of the river. None appeared to be fully mature and all specimens taken were in faded white juvenal plumage. As our attention was later largely directed away from this quarter we are unable to say whether or not these individuals remained throughout the summer, although we are inclined to think that they did not. In 1930 Lloyd and Gould did not see the species at Fort Prince of Wales camp from September 19 to 28, but Lloyd reported it as common in the harbor about the docks from about the end of October to at least the middle of November.

In 1932 Twomey collected specimens off the mouth of the river on July 16, 20, and 21.

77. **Larus argentatus** Pontoppidan. HERRING GULL.

Common summer resident; breeds rarely in the immediate neighborhood.

In 1930 it was present in numbers at the time of our arrival on May 28, and until the ice went out there was always a considerable flock about the garbage piles on the edge of the floe, and later about the mouth of the river between Eskimo Island and the Merry Rocks. A large proportion of these birds were sub-mature. The species greatly increased in numbers about August 25, and remained abundant until the record closed October 4. Lloyd saw a few juveniles as late as November 2. In 1931 and 1932 conditions were similar, but on July 2, 1932, Twomey found a nest with two downy young on a rock in a small lake northeast of Lake Rosabelle.

All specimens examined, except one, are typical of the heavily wing-marked form generally accepted as *L. argentatus smithsonianus.* One, No. 32-8-27-147, in the Royal Ontario Museum of Zoology, Toronto, taken by Twomey July 20, 1932, is a small-sized female moulting into the fourth year plumage, the wings and tail being obviously of a previous year's growth, while the body plumage is fresh and new. The dark pattern of the wing-tips is both pale and restricted for this stage of *smithsonianus*, the specula of the two outer primaries are very large, and that of the second almost joined to the gray basal wedge. The senior author refers the specimen to *L. a. thayeri.*

78. **Larus kumlieni** Brewster. KUMLIEN'S GULL.

Probably non-breeding individuals are of regular occurrence in summer. Many of the larger gulls remain wanderers until full breeding maturity urges them to their nesting-localities. In 1932 Twomey took a faded, not quite mature female gull that seems to be what might be expected of the sub-adult of this species. This specimen is now in the Royal Ontario Museum of Zoology, Toronto (numbered 32-8-27-148), from whence the senior author had the privilege of borrowing it for examination. He would say that it is in its fourth summer, moulting into fourth winter adult plumage. The wings and tail are old, much worn and faded and with obvious juvenile characters, but the body plumage is new, fresh and apparently of adult type.

In 1930 two specimens of similar character were taken, which upon close examination appear to be of this species. One, N. M. C. 23,912, June 10, is practically identical with the above, though the flight feathers show less evidence of extreme weathering and are several shades darker. The other, N. M. C. 23,953, June 17, seems to be in the moult of the second summer, with wing and flight feathers (though much faded and worn) agreeing closely with the plumage of this species illustrated in color by Dwight (*Auk*, XXIII, 1906, Pl. I).[6]

MEASUREMENTS IN MILLIMETERS.

Mus.	No.	Sex	Date	Culmen	Height of bill at base	Wing	Tarsus	Middle Toe and Nail
R. O. M. Z.	148	♀	July 16, 1932	44	16	385	59	59
N. M. C.	23912	♀	June 10, 1930	45	15.5	380	57	56
	23953	♀	June 17, 1930	45	15	385	61	56

According to the junior author, three white-winged gulls were noted in a great flock of Herring Gulls on May 26, 1931, about the garbage piles on the ice near the townsite. Two of these were undoubtedly Glaucous Gulls; but one was noticeably smaller, of Herring Gull size or even slightly less. The bird was shot but could not be retrieved and at the time was recorded as an Iceland Gull. Faded *kumlieni* in life would, however, except under the most unusual circumstances, have an exactly similar appearance, and there is a strong possibility that the bird in question was of that species.

Kumlien's Gull in sub-maturity most closely resembles the Iceland Gull, *L. leucopterus*. The size is about the same but the blue mantle as it appears averages a little darker, although occasional specimens are quite as light. The general pale ashy brown washes and the light brownish flecking of the mantle are about the same in the younger stages of the two species. Early plumages can probably be best distinguished from that species by the lighter colored primaries—in first winter hair brown[7] fading to drab gray at tips instead of light drab extensively fading to white. The adult more closely approaches

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[6] This specimen was originally figured by Dwight as a "juvenal" or first summer plumaged Kumlien's Gull. Later, in his paper on the "Gulls of the World," p. 252, he reidentified it as an Iceland Gull in the second winter. It is difficult to understand this later decision, for no one knew better than Dr. Dwight that no second-year gull can normally have darker, more generalized primaries than it had the first year, as would be the case under this reconsidered identification. Though the specificity of this specimen was arrived at by a process of elimination rather than by actual knowledge of parental origin, the first identification was almost certainly correct.

[7] Colors from Ridgway's "Color Standards and Color Nomenclature," 1912.

argentatus but is smaller, with shorter, lighter bill, and the mantle averages a little paler. The black primary-tips of that species are replaced by a pale gray pattern of reduced extent. In some specimens this pattern may be nearly as extensive and almost as dark as in some specimens of *L. argentatus thayeri*, while in others it may be reduced to inconspicuous traces or occasionally absent altogether. It is uncertain whether this variation is an age succession or not.

These birds are just about what would be expected of *kumlieni* under these postulates. The senior author is convinced that Kumlien's Gull is a distinct species and not a hybrid as is represented in the last A. O. U. "Check-List." He bases his conclusion on evidence obtained by Soper, 1928-1931, who found it breeding in pure communities as well as associated with *L. argentatus smithsonianus* and *L. hyperboreus* on southwestern Baffin Island, as well as on his own researches that have failed to find any but negative evidence of the breeding of *L. leucopterus*, one of its postulated parents, anywhere in the Canadian Arctic. It will be observed that with a breeding-station for the species at the mouth of Hudson Bay the occurrence of *kumlieni* in non-breeding condition in summer at Churchill is not only possible but very probable.

79. **Larus delawarensis** Ord. RING-BILLED GULL.

Preble (1902) took an immature Ring-billed Gull fifty miles below Cape Eskimo on August 8. This record is within a hundred miles north of Churchill, and is presumptive evidence of its occasional occurrence here.

80. **Larus philadelphia** (Ord). BONAPARTE'S GULL.

Common summer resident; breeds. This species arrived in 1930 in small numbers on May 30. By June 2 it was common, feeding on the garbage piles on the ice and frequenting the slough within the townsite in considerable numbers. Later it was found nesting at Landing Lake and other lakes a few miles inland. The nests were well built of moss and lichens, like magnified Olive-sided Flycatcher's nests, and were situated in spruce trees, on ridges between or adjacent to the lakes and ponds. There were many more old nests than occupied ones and the relics of many generations of nesting were seen. These nests were not found until July 20, when the young, nearly half grown and out of the nest, were swimming about the ponds. In 1931 Twomey took the first completely downy young ever brought to the attention of ornithologists and a July 21 specimen submitted to the senior author can be described as follows:

Ground-color, light brownish buff (nearly tawny olive of Ridgway's "Color Standards and Color Nomenclature," 1912), darkest on back, lightening to deep cream of same tint on crown, face, chin and abdomen, leaving a slightly darker breast or fore-neck band. Above, and on thighs and wings, many spots and curious, indefinite meanderings of black. Crown, face, and sides of throat with scattered, sharp black spots, largest on sides of upper throat and under cheeks. In general, much like the comparable plumage of Franklin's Gull, but appearing to be of slightly deeper, richer coloring and with sharper and better defined spotting.

The species remained constantly common, being noted daily until September 24, after which only a few individuals were seen, on September 26 and October 2.

In 1931 the species arrived on May 23, when two were seen on the townsite slough in company with several Herring Gulls. Large numbers of birds were seen on May 27 and 29. On June 12, in the wooded districts near Landing Lake, the gulls scolded us as if they had chosen their nesting-territories. On June 19 an incubating female was collected, and on July 1 nests with three eggs were found by Lloyd and Sutton near Landing Lake. During the following week Semple and Pettingill found other nests and on July 6 Twomey took the first downy young.

81. **Xema sabini** (Sabine). SABINE'S GULL.

Rare transient. Not noted in 1930. On June 5, 1931, Pettingill collected a female from a flock of Bonaparte's Gulls which were feeding and circling about the townsite slough. On June 8 Sutton took another female about six miles up the river. On June 9 one was seen along the river-bank, not far from the mouth, and on June 10 Semple took a male.

In 1933 Twomey took adult specimens on June 28.

82. **Sterna paradisaea** Brünnich. ARCTIC TERN.

Common transient and summer resident; breeds. In 1930 the first Arctic Terns were seen on June 2. Thereafter they were common. Throughout the summer a considerable number frequented the mouth of the river, where the conflicting currents brought many tidbits to the surface but where they were also continually badgered by Parasitic Jaegers. They nested on a little mossy islet on a tundra pond near the Lake Rosabelle camp. The nests had been robbed by Indians and when we visited the island July 11 many were empty or with incomplete sets of eggs. Some young, still in complete down, from nests the Indians had overlooked, had hatched. These chicks took to water at our approach, but their swimming was premature and we rescued many that were watersoaked, exhausted and obviously drowning. We suspect that some were blown too far from their island to return and we disturbed them as little as possible thereafter. Their taking to water seemed more the result of parental suggestion and excitement than of innate fear, for many of the tiny paddlers that struggled strenuously away, when once overtaken by our canoe turned to us with evident relief, rested contentedly in the hand and even accepted freedom with reluctance, following us as if wanting to experience again the rest and warmth.

There is considerable variation in the coloration of the newly hatched young and two color-phases are evident. The dark one is strongly dull ochre in ground-color while the light one is cream, almost white, giving a generally pale ashy instead of dull or muddy buff effect. Food for the young probably is procured in the Bay or in the river. The tundra lakes are shallow, freezing to the bottom in winter. So far as we know they contain no fish, and insect life in them appears to be very scarce. The bottoms are clean, hard gravel without vegetation, and the only life we saw in them were some snails and a few pollywogs of an undetermined species of frog that was looked for but not found.

Arctic Terns remained common until August 27, when the bulk of them left. The last record (a single bird) was made September 4.

In 1931 the Arctic Terns arrived on May 29, when two were seen about the open water some seven miles up-river. On May 30 four were seen at the river-mouth and thereafter the species was seen every day. The first complete sets of eggs were found on June 23.

Twomey reports about ten thousand nesting on the Fox Islands, some nineteen miles east of Churchill, on July 7 and 8. Nests were situated only a few feet apart, and the birds defended their territory with vigor, one taking the skin off his head in its attack.

In 1933 Twomey found them nesting in numbers at Cape Churchill from July 3 to 8.

We have no evidence of the occurrence of the Common Tern, *Sterna hirundo*, numbers of which might well occur among the flocks of Arctic Terns without being recognized.

83. **Hydroprogne caspia** (Pallas). CASPIAN TERN.

On June 19, 1931, Twomey took a male Caspian Tern, which he deposited in the National Museum. The crown is flecked with white and the bird is probably a sub-mature.

84. **Chlidonias nigra** (Linnaeus). BLACK TERN.

Summer resident, probably rare as a rule; nests locally. On July 7, 1932, Twomey found several pairs nesting on the small fresh-water ponds in the interior of the Fox Islands, some nineteen miles east of Churchill. They already had hatched their young, which were seen swimming about the reedy shores.

Uria aalge (Pontoppidan). COMMON MURRE.

Hypothetical. There is no unquestionable evidence that this Murre occurs in Hudson Bay. In the light of present knowledge it seems probable that the species normally does not extend up the Labrador coast much beyond Nain or into Hudson Strait, where the Brünnich's Murre, *Uria lomvia* (which is so much like *aalge* as not to be readily separable from it in the field), is common. There is a specimen of *aalge* in the National Museum of Canada labelled "Hudson Bay." This was taken by Bell on his *Alert* expedition of 1885, but since no definite locality is given it is not certain that the specimen was taken in the Bay itself. Richardson ("Fauna Boreali-Americana," II, 1831, p. 477) describes two specimens from York Factory. One of these, being of the *ringvia* type, peculiar to *aalge*, would substantiate the occurrence of the present species in Hudson Bay if the locality could be completely relied upon. If this species is ever more than an occasional straggler on the southern waters of Hudson Bay it will almost certainly eventually be noted at Churchill. Common Murres taken in this region should be referable to the eastern race, *Uria aalge aalge*, the Atlantic Murre.

Uria lomvia (Linnaeus). THICK-BILLED MURRE.

Hypothetical. The eastern form of this species, Brünnich's Murre, *Uria lomvia lomvia*, is the common murre of the northern part of Hudson Bay. It almost certainly occurs over most of the Bay. It has been reported in winter from Great Whale River; the senior author has observed it well south of Cape Eskimo in summer; and the junior author has taken it along Southampton Island's southern shore in spring and summer. Its occasional occurrence off Churchill is almost a certainty, but we have no definite record at present.

85. **Cepphus grylle** (Linnaeus). BLACK GUILLEMOT.

Preble (1902) saw a guillemot on Button Bay near Churchill on August 19. The species has been recorded twice during recent years: five seen by Lloyd off Eskimo Island at the mouth of the river, on August 6, 1930; and one seen by Twomey on July 15, 1933. No specimens have been taken, but the form almost certainly is that listed by Preble, Mandt's Guillemot, *C. g. mandti.* This race is known to inhabit the northern part of the Bay and to occur at Great Whale River; and it is not probable that the more southerly *C. g. grylle* ever occurs in Hudson or in James Bay.

86. **Zenaidura macroura** (Linnaeus). MOURNING DOVE.

Rare casual visitor. On June 21, 1930, near the river at Mosquito Point, Lloyd picked up desiccated fragments of the head and wing of a Mourning Dove, enough to identify the species, but insufficient for the determination of the subspecies.

87. **Ectopistes migratorius** (Linnaeus). PASSENGER PIGEON.

Probably formerly an occasional visitor; now extinct. Though Bell (1880) tells us that this species has never been known at Churchill, Clarke (1890) reports an adult male and a female taken there previous to 1845.

88. **Bubo virginianus** (Gmelin). GREAT HORNED OWL.

Probably an occasional visitor to the forest-edge; nests rarely and locally. Preble (1902) tells us of a specimen reported by Clarke (1890) ascribing it, on geographical considerations, to *B. v. arcticus* (Swainson) = *B. v. subarcticus* Hoy, of the present "Check-List."

In 1930 Lloyd and Sutton saw a Great Horned Owl several times in the more or less open woodlands northeast of Lake Rosabelle on September 4. The bird was decidedly whitish in general appearance.

In 1931 Sutton saw another rather white individual in the deep woods not far from Landing Lake on June 6.

On June 28, 1933, Twomey caught alive near the round-house a young bird just beginning to fly. He kept it as a pet for some time. A photograph of this bird (taken by Miss Heydweiller) has been critically examined by the junior author and there is no doubt that the individual is very light in general color-tone—whitish rather than buffy, if it be safe to judge by comparison with photographs of young Great Horned Owls taken in the eastern United States. One other young bird was picked up by workmen on July 1. No adult birds were seen, and the location of the nest is unknown.

Judging from what we know of the distribution of the Horned Owls, the race represented at Churchill should be *B. v. subarcticus*, the so-called Arctic Horned Owl. This concept is strengthened by the fact that birds seen in life were whitish. The locality nearest Churchill from which a National Museum of Canada specimen of *subarcticus* has been taken is Herb Lake, Manitoba, about three hundred and fifty-five miles to the southwest. This specimen, a November bird, and possibly a migrant from farther north, is light-colored, but not strikingly white. In fact, the general assumption that the farther north we go the whiter we find the Horned Owl is not in harmony with the evidence. According to rather a large series in the Canadian National Museum, the whitest breeding birds are to be found not in the far north but in the dry belt of Saskatchewan and Alberta near the international boundary.

89. **Nyctea nyctea** (Linnaeus). Snowy Owl.

Regular winter visitor and occasional summer resident; nests.

In 1930 a fresh dead bird was picked up by some workmen on May 26 and presented to us. It was extremely emaciated and seemed to have come to its death through starvation or attendant ills. A few days later Lloyd found another dead bird in the same starved condition near Fort Prince of Wales. Systematic trapping developed the fact that mice and lemmings were decidedly scarce. Old workings were evident and plentiful, but fresh ones very few. In most places, a dozen traps did not yield more than two or three small mammals a week.

In 1931 the species was observed several times. On May 25 one was seen flying low along the ridge not far from the Bay. On May 27 one was heard hooting about four miles east of the river-mouth. On May 29 one was seen along the river-bank about six miles inland. On June 2 two were seen along the frozen river and on June 13 another near camp at the river-mouth. On June 24 one was noted not far from the townsite and on June 26 a very white individual was observed at Button Bay.

From the above paragraphs it will be observed that Snowy Owls were more frequently seen in 1931 than during the previous year. During 1931 small rodents were apparently fairly numerous, lemmings being seen several times near camp and other small mammals being observed on the tundra or in the woodlands from time to time.

In 1932 Twomey saw one near Lake Rosabelle on June 3.

In 1933 Twomey found a nest containing eight young at Cape Churchill, on July 6. The male parent, an almost immaculate bird, was very active in defence of its young but its mate watched proceedings from afar and took no particular interest in them. The young were in various stages of development: the youngest in white down, just from the egg, the eldest from ten to twelve days old, gray, with pin-feathers well developed in wings and tail and just appearing on body.

90. **Surnia ulula** (Linnaeus). HAWK OWL.

Clarke (1890) reports a specimen taken at Churchill previous to 1845.

91. **Asio flammeus** (Pontoppidan). SHORT-EARED OWL.

Summer resident; nests irregularly. In 1930 the species was not common through the summer. Single birds were seen on various days in June and July and one was taken in the dwarf shrubbery back from the tidal flats of the river. Three were noted on September 30.

In 1931 the species was noted several times during spring and summer. It was first recorded on May 27, when three birds were observed circling stiffly about high in air, as if going through some sort of courtship ritual. One was flushed from the deep woodland on June 11, where it had evidently been feeding on a Solitary Sandpiper. On June 26 two were seen at Button Bay.

In 1932 the species was not recorded.

In 1933 the species was common and twelve nests were found by Twomey and Farley. All these contained large sets of eggs, six or seven as a rule, and in one case eight. Why this sudden increase in the number of Short-eared Owls? Why all these nests, when we failed to find a single nest in 1930, 1931, and 1932?

Obviously, the abundance of lemmings, and perhaps of other small mammal life, in 1933 made possible the nesting of this raptorial species as well as such other mouse-eaters as the Snowy Owl, Rough-legged Hawk and Parasitic Jaeger. The effect of periodic abundance of small mammals upon the breeding range of certain bird species is well brought out by our four-year survey of the Churchill region.

92. **Chordeiles minor** (Forster). NIGHTHAWK.

Clarke (1890) reports a Nighthawk taken at Churchill previous to 1845. We did not see it in 1930. On June 28, 1931, we saw two flying high in air over the river-mouth, calling loudly, and headed northwestward.

93. **Megaceryle alcyon** (Linnaeus). BELTED KINGFISHER.

Clarke (1890) records an adult female taken at Churchill previous to 1845.

94. **Colaptes auratus** (Linnaeus). YELLOW-SHAFTED FLICKER.

Uncommon summer resident; nests. In 1930 Flickers were heard or seen in the region of Landing Lake on July 2 and 3. On July 25 a family recently from the nest was discovered in the spruce bush along the railroad track and two juveniles were taken. Only one was recorded thereafter: September 3.

In 1931 Flickers were noted several times, first on May 29, when a single bird was seen near camp, climbing about the rocks; on June 4, when one was heard singing its spring "song" from a dead spruce in a "burn"; on June 15, when a female which had been incubating eggs was collected; on June 16, when a male was noted near Landing Lake; and on June 22, when two were seen.

In 1933 Twomey saw three pairs of Flickers nearly every day from June 10 to July 25 between Rosabelle and Landing Lakes.

95. **Sphyrapicus varius** (Linnaeus). YELLOW-BELLIED SAPSUCKER.

Clarke (1890) records an adult female Sapsucker taken at Churchill previous to 1845.

96. **Dryobates villosus** (Linnaeus). HAIRY WOODPECKER.

Clarke (1890) reports an adult male taken at Churchill previous to 1845.

Judging from specimens from the more northern parts of Ontario, Manitoba, and other more or less adjacent localities, examined by the senior author, the geographical probability is the Northern Hairy Woodpecker, *D. v. septentrionalis.*

97. **Picoides tridactylus** (Linnaeus). LADDER-BACKED THREE-TOED WOODPECKER.

Probably a rare permanent resident in the wooded areas. Clarke (1890) reports five specimens of "*Picoides americanus*" taken at Churchill previous to 1845.

In 1930 a male was taken near Mosquito Point on June 28. Its testes were small and showed no particular signs of breeding. On September 6 Lloyd took a male and female. The latter female and the former male are notable for the small amount, almost the absence, of white barring on the back.

On June 11, 1931, in deep spruce woodland about five miles from the townsite, Sutton took a male that plainly had been incubating. Prolonged search in the neighborhood disclosed the location of several unused drillings or nests but neither the occupied nest nor the female was discovered. On June 29 Lloyd took a female at Mosquito Point across the river.

All specimens are referred to the eastern American race, *P. t. bacatus.*

98. **Otocoris alpestris** (Linnaeus). HORNED LARK.

Very common transient and summer resident; nests abundantly. In 1930 Horned Larks were very numerous when we arrived on May 28. They were everywhere, feeding confidingly with Snow Buntings even about the doorsteps of the offices and workshops of the townsite. They sang more persistently and finely than we had ever heard them before. The male of a pair nesting close to our Churchill camp habitually perched on the ridge-pole of the tent and sang continuously for many minutes, deserting his post only for momentary feedings or when he flew to the adjoining tennis-court, where he continued to sing. About June 10 the species became less noticeable about the dooryards, but continued abundant all over the tundra.

On our arrival, there were obviously two races present. In one the male had a strong yellowish wash on the face; in the other the face was much duller and grayer. The two forms were quite distinguishable in life and were respectively, the so-called Northern Horned Lark, *O. a. alpestris*, and Hoyt's Horned Lark, *O. a. hoyti.* Most of the yellow-faced birds left with the transients, though a few less distinctly characterized individuals remained and bred, mating sometimes with perfectly typical *hoyti*. The species remained in about constant numbers to the end of September and were still present when the records closed on October 4.

In 1931 many Horned Larks, both *hoyti* and *alpestris*, were noted by Lloyd on May 18. They were seen commonly every day thereafter and many nests were found. The first nest, found on June 13, contained a single egg. Young birds in the nest were first noted on June 18. One nest was found in the middle of camp, built on a low pile of shavings.

99. **Iridoprocne bicolor** (Vieillot). TREE SWALLOW.

Clarke (1890) reports an adult male taken at Churchill previous to 1845. In 1930 single birds were observed flying about the staff offices on June 6 and 10. In 1931, on June 15, 22, and 24 one, two and three Tree Swallows, respectively, were seen flying about the townsite.

100. **Petrochelidon albifrons** (Rafinesque). CLIFF SWALLOW.

Two Cliff Swallows were observed on June 10, 1931, near the townsite. These were easily recognized by the tan-colored rump-patch.

101. **Perisoreus canadensis** (Linnaeus). CANADA JAY.

A permanent resident, moderately common in the bush lands, and usually seen in family groups. In 1930 sooty juveniles were seen at least as late as the end of July. The species did not seem to become any more numerous later in the season and was noted only occasionally through August and early September.

In 1931 Jays were noted several times, sometimes in large family groups, the young begging for food; or adults in much worn plumage. Young birds seen on June 9 had tails only about two inches long.

Specimens collected are referable to the eastern race, *P. c. canadensis.*

Cyanocitta cristata (Linnaeus). BLUE JAY.

Hypothetical. Macoun (1909) quotes Bell to the effect that this species has been taken at Churchill, but we have been unable to locate the statement in Bell's published writings. It may have been given verbally or in manuscript. There is nothing very improbable in an occasional Blue Jay's wandering northward to the forest-edge, but without confirmation it is best to regard the record as hypothetical.

102. **Corvus corax** (Linnaeus). RAVEN.

A regular though not common permanent resident; probably nests in the vicinity. Lloyd says that Ravens are not uncommon in winter. In 1930 one was seen and heard on May 31 on the townsite point. Two dull-colored juveniles were taken on August 8, and others were seen throughout September. Four were the most noted in any one day, and these probably constituted a family party.

In 1931 the species was recorded only on June 8 and 9.

In 1932 Twomey found one dead on June 2, on the tundra near the pipe-line.

No specimens suitable for subspecific determination are available and the race is, by conventional inference, the northern race, *C. c. principalis.*

103. **Corvus brachyrhynchos** Brehm. AMERICAN CROW.

Uncommon summer resident; nests. In 1930 a crow was heard about the townsite upon our arrival and two were seen at Mosquito Point as we were making camp on June 18. On July 24 a family was located in the bush along the railroad track and a young, barely fully fledged bird was taken on September 3.

In 1931 Crows were noted several times, first on May 30, when one was seen and heard about the townsite; on June 4, when one was heard in the bush about five miles inland from the river-mouth; on June 8 and 9, when a pair were noted at about Mile 506 on the railroad; on June 12, when Sutton took a male; and on June 15 and July 1, when one or two birds were heard.

In 1932 Twomey saw one on May 29 but none after June 9.

The 1930 specimen is hardly developed enough for definite subspecific determination but the male taken June 12, 1931 is, in the opinion of the junior author, the well-known Eastern Crow, *C. b. brachyrhynchos.*

104. **Penthestes hudsonicus** (Forster). BROWN-HEADED CHICKADEE.

Rather rare; probably a permanent resident. In 1930, on June 21 and 28 respectively, a male and female in worn plumage were taken at Mosquito Point. Occasional single birds were noted from August 15 to September 6, when a well plumaged female was taken.

In 1931 Chickadees were noted several times during the spring and summer, three specimens being taken on June 6, a male being taken at Mosquito Point on June 29, and a nest and five eggs being found in an old excavation of a Three-toed Woodpecker on June 11. The nest was made largely of fur of the Varying Hare.

In 1933 Twomey saw two on June 18 among the spruces near the railroad "Y."

Specimens secured are probably referable to the Hudsonian Chickadee, *P. h. hudsonicus.*

105. **Sitta carolinensis** Latham. WHITE-BREASTED NUTHATCH.

Clarke (1890) records a specimen of White-breasted Nuthatch taken at Churchill before 1845.

Sitta canadensis Linnaeus. RED-BREASTED NUTHATCH.

Hypothetical. Rae (1850) tells us that a specimen of Red-breasted Nuthatch was taken flying over Broad River, between Churchill and York Factory. This record is from about fifty-five miles south of Churchill and suggests the possible occurrence of the species here.

106. **Turdus migratorius** Linnaeus. AMERICAN ROBIN.

Fairly common summer resident; nests. Many nests were found both in 1930 and 1931. Most of these were situated in low spruces or in the scaffolding or piles of ties about the construction camp.

In 1930 Robins were noted as late as September 6.

In 1931 the species arrived apparently on May 24, when the Rev. Samuel Martin recorded one. On the following day one was heard singing about the camp. Nest-building began on May 26. The first complete set of eggs was found on June 6.

The National Museum material is not sufficient for final decision as to the subspecies represented. The junior author thinks the 1931 specimens are doubtfully referable to the eastern race, *T. m. migratorius.* It seems best at the present moment, however, to include them under this form.

107. **Hylocichla minima** (Lafresnaye). GRAY-CHEEKED THRUSH.

Fairly common summer resident; nests in the denser spruce bush. The only species of thrush noted. In 1930 it was first seen on June 6. On this date it was common. More often heard than seen, it was noted in its proper habitat practically daily throughout the summer. A nest with heavily incubated eggs was found under a small spruce on

June 25. The species was occasionally noted throughout August and as late as September 6.

In 1931 the Gray-cheeked Thrush arrived on June 2, when one was noted. It became common four days later. A pair were found building on June 18, and four heavily incubated eggs were found on June 25. Many nests with from two to four fresh eggs were found on June 26, at Button Bay. Most of these were placed on the ground under spruces, or in wet places between the bases of willow shrubs. Semple found one nest about three feet from the ground in a spruce tree on June 26.

In 1932 Twomey found occupied nests on June 16 and 23. Both were in small bushes two or three feet from the ground.

Specimens taken are referable to the northern race, *H. m. aliciæ*, which is apparently characteristic of the Hudsonian Life Zone across the continent of North America.

108. **Sialia** sp. ? BLUEBIRD.

Twomey took a very young Bluebird on June 10, 1931, in the spruces three miles south of "town," but the species was not recognized and unfortunately the specimen was lost. It is a matter of conjecture whether this bird was *sialis* or *currucoides*.

109. **Regulus satrapa** Lichtenstein. GOLDEN-CROWNED KINGLET.

Probably an occasional visitor to the forest-edge.

In 1932 Twomey saw two on June 11, near the gravel-pit, and collected a female. Single birds were seen on June 20 and 25, and two on June 27.

In 1933 Twomey saw several at Landing Lake on June 18 and four more on June 25.

110. **Corthylio calendula** (Linnaeus). RUBY-CROWNED KINGLET.

Uncommon summer resident; nests irregularly in the spruce woods. In 1930 one was taken of three seen on September 5, and a single bird was noted the following day.

In 1931 a single male, singing brilliantly, was observed on June 4, and the species was thereafter noted several times on June 6, 8, and 11. On the latter date two males were observed chasing each other. On June 29 a male was taken at Mosquito Point. An old nest was found in a spruce tree not far from the railway track.

In 1932 it was very common in the spruce woods about the gravel-pit, where it could be heard singing at any time.

The singing male taken in 1931 is referable to the eastern race, *C. c. calendula*. Fall specimens are not readily identifiable.

111. **Anthus spinoletta** (Linnaeus). PIPIT.

Fairly common transient and summer resident; nests among the rocky hills and in the more "arctic" localities. In 1930 we found it present on our arrival, May 28. Three males taken June 12 are in the rufous-breasted, gray-backed plumage, while those taken thereafter are all in the usual dull olive. It is still uncertain just what these two very distinct plumages represent. Pipits increased greatly in number from August 5 to near the end of the month, and twenty-five were noted daily instead of the two or three on occasional days as previously. They remained common until about September 22, after which they became rarer and none were noted after September 30.

In 1931 Lloyd saw the species first on May 22. On May 25 three were seen, and on the following day Pipits were everywhere. Lloyd found a nest with four eggs, built into the side of a ditch near the gravel-pit. On June 20 this nest was destroyed by the caving in of the ditch. On July 4 Sutton collected a nest and five eggs along the rocky ridge bordering the Bay east of the river-mouth.

112. **Bombycilla garrula** Linnaeus. BOHEMIAN WAXWING.

Irregular summer resident; probably nests during some years. Three were noted by Preble (1902) on July 25, 1901. While this waxwing was seen in considerable numbers during the summer of 1930, and evidently nested, there can be no doubt that it is very local; and the fact that it was not once noted during 1931, 1932, and 1933 makes it apparent that it is also highly irregular.

In 1930 Bohemian Waxwings were seen in the muskeg of Sea Horse Gully and at the edge of the bush along the river-plain just above Mosquito Point. They cruised about in small, loose groups, alighting on the tips of the tallest spruces, sitting placidly there for a few moments, dashing off to circle erratically, then often returning to the very perches whence they started. So far as we could see, they were not catching insects, as Cedar-birds commonly do, nor winnowing the air like swallows, but merely disporting themselves. Of the seven specimens taken, six were males, the one female having a bare space on the belly indicative of breeding.

113. **Lanius borealis** Vieillot. NORTHERN SHRIKE.

Irregular summer resident; probably nests. Clarke (1890) records specimens taken at Churchill previous to 1845 and Preble (1902) found them rather common in 1900. Our failure to find them in 1930 may have been due to the scarcity of small mammal life mentioned under the heading of the Snowy Owl.

In 1931 Semple took a singing male on June 15, and Twomey and Farley took specimens on June 15 and July 3. The first of these (the only one available at present) is referable to the eastern race, *L. b. borealis.*

114. **Vermivora peregrina** (Wilson). TENNESSEE WARBLER.

Common but local summer resident; nests. In 1930 this warbler was not noted until June 22 (Mosquito Point); but thereafter it was found to be fairly common in limited areas in the bush. Parent birds feeding young were observed on July 18, but the species was not recorded after this date.

In 1931 two males were taken at Mosquito Point on June 29, and one was seen on the opposite bank of the river on the following day.

115. **Vermivora celata** (Say). ORANGE-CROWNED WARBLER.

Rare summer resident; almost certainly nests. On June 16, 1931, Sutton collected a singing male with much enlarged gonads in a "burn" at about Mile 506, west of the railroad track. On June 29 a male was taken and another singing male seen at Mosquito Point. On July 3 a singing male was taken in a clump of tamaracks in the Landing Lake district.

These specimens all are referable to the eastern race, *V. c. celata.*

116. **Dendroica aestiva** (Gmelin). YELLOW WARBLER.

Summer resident; nests. In 1930 not common and quite local. A few pairs inhabited the scrub willows along the river at Mosquito Point where, on June 19, a nest with eggs was found. In this same place ten were noted on August 15 and one on the 18th.

In 1931 the species was recorded at several additional points. A singing male was seen and heard along the slough in the townsite on June 17. On June 22 a male with enlarged gonads was taken near the town. On June 24 another male was taken along the river-bank and on July 26 one was taken at Button Bay. On June 29 many were seen and a pair taken in the willow shrubbery at Mosquito Point.

Specimens examined by the junior author are referred provisionally to the eastern race, *D. a. æstiva.*

117. **Dendroica coronata** (Linnaeus). MYRTLE WARBLER.

Probably a rare summer resident in the higher timber; may nest. Clarke (1890) records two male Myrtle Warblers taken at Churchill previous to 1845. The species was not seen in 1930. In 1931 Sutton and Semple saw a male on June 9; it was very wary, flying from one clump of stunted spruce to another as if disturbed at being in unfamiliar and inhospitable surroundings.

118. **Dendroica striata** (Forster). BLACK-POLL WARBLER.

Summer resident; nests; the commonest warbler of the region. In 1930 it was first noted on June 6. Thereafter it was found to be fairly numerous wherever there was spruce bush. A nest with eggs was found on June 25. It was noted occasionally through August and until September 6.

In 1931 it arrived June 2, on which date a male was taken. The first nest (four fresh eggs) was found at Button Bay on June 26. Another nest with five well incubated eggs was found on the ground on July 3.

119. **Dendroica palmarum** (Gmelin). PALM WARBLER.

Probably a rare and casual visitor. One specimen is reported by Clarke (1890) as taken at Churchill before 1845. In all probability this was *D. p. palmarum*, the more westerly race.

120. **Seiurus noveboracensis** (Gmelin). NORTHERN WATER-THRUSH.

Not uncommon summer resident, breeding in suitable localities.

In 1930, in the scrub willow along the river at Mosquito Point, Water-Thrushes were exceedingly common, but so decidedly shy and in such dense cover as to be difficult to collect. Only two specimens were taken (June 8 and 19), one of these a female with fully formed egg in the oviduct. The species was last seen on August 15.

In 1931 it was first recorded on May 28, when a male was taken in the wet spruce woods at about Mile 506 along the railroad tracks.

On June 6 four were seen and a male and female collected. The species was seen almost daily thereafter in suitable country, especially at Mosquito Point and Button Bay.

In 1932 Twomey saw and heard six at Goose Creek on June 6.

Preble (1902) obtained specimens here that he calls intermediate between *Seiurus noveboracensis noveboracensis* and *Seiurus noveboracensis notabilis*, but nearer to *notabilis*.

All specimens taken in 1930 and 1931 examined by us are intermediate between the white and yellow extremes, perhaps slightly closer to the latter than to the former, and are therefore corroborative of the above identification. However the senior author acknowledges some uncertainty as to the validity or the assumed range of *notabilis*. In the National Museum of Canada are 98 specimens of this species taken with very even distribution across the continent from Nova Scotia to British Columbia and north to the north shore of the Gulf of St. Lawrence, Northern Ontario, Churchill, Banks Island and Mount Logan. White *noveboracensis* and yellow *notabilis* with their accompanying characters are scattered indiscriminately throughout the series. Many of these are undoubtedly migrants, but in some forty whose collection dates fall within June and July and that can be taken as fairly representative of breeding stock, practically the same confusion persists. Neither can the distinctions be ascribed to age as there are ultra-typical examples of both races in young birds with ungranulated skulls. This may not completely dispose of the subspecies *notabilis* but until some definite distributional distinction can be correlated with the postulated subspecific characters it seems best to withhold full approval of the race, or to regard it as the extreme development of individual variation in a highly variable species.

121. **Geothlypis trichas** (Linnaeus). YELLOW-THROAT.

Probably a rare and local summer visitor. In 1931 Twomey saw two on July 12 along Goose Creek, some fifteen miles south of Churchill. In 1932 he saw four in the same place. As he was unable to collect any of these it cannot be stated whether they were *G. t. brachidactyla* of the east or *G. t. occidentalis* from the prairies.

122. **Wilsonia pusilla** (Wilson). WILSON'S WARBLER.

Probably a casual summer visitor. Lloyd collected a female from a stunted spruce thicket along the river-bank on May 27, 1931.

123. **Passer domesticus** (Linnaeus). ENGLISH SPARROW.

Rare summer resident at the townsite. In 1930 a pair occupied the navigation beacon on the townsite point. They were exceedingly inconspicuous as if they felt that in this far northern clime they were intruders and out of place. Though we passed directly under the nest several times every day when in the townsite, we discovered them by accident, and they were seen and heard only a few times all summer.

In 1931 Lloyd took a male at this same beacon.

Twomey reports that twelve spent much of the winter of 1931-32 in the round-house but in spite of being fed with grain by the railroad men they all perished before spring, supposedly freezing to death.

124. **Sturnella neglecta** (Bonaparte). WESTERN MEADOWLARK.

Probably a rare or casual summer visitor. On June 1, 1931, Pettingill saw a Meadowlark but did not succeed in collecting it. It flew up from the open tundra along the river-bank about a mile from the mouth.

In 1932 Twomey noted one every day from June 10 on. As it was noted by and under the particular protection of the men working on the townsite it could not well be collected. Its song was the same as that of the Western Meadowlark he knows in Alberta.

125. **Euphagus carolinus** (Müller). RUSTY BLACKBIRD.

Common summer resident; nests. In 1930 the first Rusty Blackbird was seen on June 4. Later the species was found to be fairly common in the more wooded localities inland. On July 23 fledglings barely able to fly were taken. According to Lloyd the species remained fairly common until about October 2.

In 1931 the species was found to be especially common in the Landing Lake district and about three miles inland from Button Bay. It arrived about June 4, when a male and female were seen and a male collected. On June 12 two males were taken. On June 26 two males and a female were taken at Button Bay and a nest containing three eggs was found by Lloyd. At least one egg had fallen from this nest, probably during a recent storm. On June 29 Sutton found a nest with six half-grown young at Mosquito Point. On July 1 parents feeding young were observed at Landing Lake.

126. **Quiscalus quiscula** (Linnaeus). GRACKLE.

Probably of only casual occurrence. Clarke (1890) under *Q. q. æneus* records an adult male Bronzed Grackle taken at Churchill previous to 1845.

127. **Pinicola enucleator** (Linnaeus). PINE GROSBEAK.

Rare and local summer resident at the forest-edge, probably more common up the river; nests. Bell (1880) notes the species as frequent on the Churchill River and surmises its breeding. Clarke (1890) records specimens taken at Churchill previous to 1845. The species was reported to Preble (1902) by residents of Churchill.

In 1930 Lloyd observed a bird on June 21, closely enough to identify it as this species.

In 1931, on June 8, Sutton collected a singing male and a female with a fully formed egg in the oviduct at about Mile 504, in a patch of very dense spruces along the railroad tracks. On July 5 Twomey saw a red male, a female, and two juveniles.

The junior author refers his specimens to *P. e. leucura.*

128. **Acanthis hornemanni** (Holbœll). HOARY REDPOLL.

Transient and summer resident; nests. In 1930 the Hoary Redpoll was seen throughout the summer, apparently in somewhat smaller numbers than the Common Redpoll, with which it freely associates. Some very high-plumaged males and, on May 31, a female with well formed eggs in the ovaries, were taken. The species was noted throughout the first half of August and one was observed by Lloyd on October 4.

In 1931 the Hoary Redpoll was seen almost daily from May 26 on, and the impression given us was that the species was fully as common as *linaria.* The two species were found flying together practically all the time and nesting actually within stone's throw of each other. It was not an easy matter to distinguish the birds, generally speaking, though the adult males were not difficult to recognize. Twomey took a set of four eggs on June 16. Semple found a nest with two eggs on June 17 that, with four eggs and the female parent, was collected on June 22. On June 24 Sutton collected a set of four from a nest built in a sheltered place in a low spruce, succeeded in securing both parent birds, and found another newly built nest not far away in a spruce about ten inches from the ground. On June 26 several pairs were seen flying about with Common Redpolls. On June 30 a nest with four eggs and the incubating female were taken. On July 1 Semple took a set of four together with the highly colored male parent.

With one notable exception the specimens collected are *A. h. exilipes*. The exception is one specimen of Greenland Redpoll, *Acanthis hornemanni hornemanni*, with unenlarged gonads, taken by the junior author from a flock of Common Redpolls in the willows along the river-bank on May 26, 1931.

Practically all records of this race in North America are from Fort Chimo, where Turner collected so many in winter, in about the year 1883; from southern Baffin Island, where Soper took a number in late autumn and winter, in 1924-1928 (specimens in National Museum of Canada); and from Southampton Island, where Sutton (1932) took specimens in spring and fall. Clarke (1890) records two specimens of *Acanthis hornemanni* taken at Churchill prior to 1845. This specific name might as well refer to *A. h. exilipes* as to *A. h. hornemanni*, so without our present Churchill specimen of *A. h. hornemanni* we could not be certain that both races actually occur.

129. **Acanthis linaria** (Linnaeus). COMMON REDPOLL.

Summer resident; nests. In 1930 the Redpoll was met with practically wherever there was a little bush. A nest was found in an isolated stunted spruce on the open tundra, half a mile from the nearest bush. The birds fed largely in the tops of the tamaracks and cruised about in small, restless flocks, flitting from tree-top to tree-top, remaining for only a few moments and then swinging off again, often after a few circlings returning to the same tree time after time. Probably these roving bands were non-breeding individuals and birds on incubation relief. The species remained common until September 6; thereafter it was noted only on September 11 and 16. According to these observations the Common Redpoll, as might be expected, does not linger as late in the fall as the Hoary.

In 1931 this species, together with the Hoary Redpoll, was seen nearly every day. Adult males were not difficult to recognize in the field; female and young birds, however, were not to be identified with certainty. Handsome *linaria* were collected on several dates. A female carrying feathers in her bill was noted on June 8. On June 9 a Redpoll was seen to feed a large insect, a crane-fly of some sort apparently, to another fully grown bird. Farley found two nests, with incomplete sets, on June 14, and Twomey found a set of four on June 16. On June 20 Lloyd found a nest with heavily incubated eggs in a leaning tamarack tree near Landing Lake. The female slipped off the nest very quietly. On June 26, at Button Bay, several Redpoll nests were found, some of them probably *hornemanni*. On June 30 Sutton took a nest with incubating female and four fresh eggs near Lake Rosabelle. This nest was not more than fifty yards away from a nest of *hornemanni*.

Specimens of this species collected apparently are all referable to the small *A. l. linaria*. *A. l. rostrata* probably is of occasional occurrence as a migrant, however.

130. **Loxia leucoptera** (Gmelin). WHITE-WINGED CROSSBILL.

Probably an erratic visitor to the forest-edge. Clarke (1890) reports adults of both sexes from Churchill taken before 1845.

131. **Passerculus sandwichensis** (Gmelin). SAVANNAH SPARROW.

Common transient and summer resident; nests. In 1930 it was already common by May 28, and remained in fairly constant numbers until September 6, after which date it was not noted. A good series was taken.

In 1931 it apparently arrived on May 27, on which date several were seen and heard. On June 23 a female with an egg ready to lay was collected. On June 27 a nest with three eggs was found near camp at the river-mouth. On June 28 a nest with six eggs was found by Pettingill.

Specimens collected are rather dark, like birds from other northern localities, or occasional late migrants from southern Ontario, and may possibly be referable to *P. s. labradorius*.

132. **Junco hyemalis** (Linnaeus). SLATE-COLORED JUNCO.

Rather rare summer resident; nests. Clarke (1890) lists two specimens taken at Churchill before 1845.

In 1930 two Juncos, probably a mated pair, were taken on June 6 in the bush near Lake Rosabelle, and a striped juvenile was collected in the same region on July 30. Two more were noted on September 20 and eight on October 3 and 4.

In 1931 Juncos were noted several times. On May 26 Lloyd took a male among the small willows near the townsite slough, and on June 4 three pairs were seen in the bush about Mile 507 along the railway. The species was recorded on June 15, 16, and 20, the last a single bird at the river-mouth.

All specimens prove to be typical *J. h. hyemalis.*

133. **Spizella arborea** (Wilson). TREE SPARROW.

Abundant summer resident; nests. In the bush lands probably the commonest bird. Found also on the tundra wherever there are scattered shrubs.

In 1930 it was present in some numbers on May 26, and remained common until September 29. It was not recorded thereafter. The great autumnal migration wave of this species reaches southern Ontario about October 1.

In 1931 the species arrived on May 25, when two males were heard singing. On the following day about ten were heard, all apparently males. On May 27 the species was abundant, both sexes being present. First nest-building activities were noted on June 11. A nest with three eggs was found on June 18, and many nests with from three to seven eggs were found thereafter. Most of these nests were situated in rather open country, often among the willows or in clearings not far from the railroad track.

In 1933 Miss Heydweiller found the species paired and in full song upon her arrival, June 5. The first nest, practically completed, was found that day. The first egg was deposited in this nest on June 11, and this egg hatched June 28. Another nest, discovered on June 29, held young at least a day and a half older than in the first nest. First eggs appeared in most nests about June 18. Young birds just out of the nest were first noted on July 8. Juvenile birds remained in the brush near their nests throughout July. No indication was noted of the rearing of more than one brood.

When Miss Heydweiller left Churchill on August 1, male Tree Sparrows were still singing intermittently on their nesting-territories; young birds were still in full juvenal plumage; and among old birds there was little evidence of the postnuptial moult. One bird collected had begun to lose the summer's plumage, however, for there were several unbroken pin-feathers among the body plumage.

All specimens collected are referable to the Eastern Tree Sparrow, *S. a. arborea*, indicating that the species arrives from the east and not from the south, since southern Manitoban transients represented in the collections of the National Museum of Canada are, without exception, plainly referable to the western race, *S. a. ochracea*.

134. **Zonotrichia querula** (Nuttall). HARRIS'S SPARROW.

Common summer resident; nests. In 1930 common throughout the season, first noted on May 28, and seen in greater numbers by June 6. A nest containing young nearly ready to fly was collected on June 27. The species remained fairly common until September 5, after which it was not noted.

In 1931 it arrived on May 27, when two were seen along the bank of the river not far from its mouth, and a female was collected. Single birds or pairs were noted practically every day thereafter, but the species was not abundant until June 4, when many birds, some of them mated, were seen in the bush country. On June 15 a bird with a piece of dry grass in its bill was seen near the ground, but no nest could be found. On June 16 a nest with four slightly incubated eggs and the brooding female were collected in the spruce woods west of the railroad at about Mile 505. Thereafter several nests were found, ten in all, with sets ranging from three to five eggs. It was found to be very common inland from Button Bay. The nests were all placed on the ground, usually on a mossy hummock in a wet place among the spruces or in a southern exposure at the edge of a burn. The females were found to flush very closely once the set was complete. A full account of the nesting of the species at Churchill was published by Semple and Sutton (*Auk*, XLIX, 1932, 166-183).

In 1932 and 1933 Twomey took several sets of eggs.

135. **Zonotrichia leucophrys** (Forster). WHITE-CROWNED SPARROW.

Very common summer resident; nests. In 1930 single birds were seen May 26 and 27, and the species was fairly common by June 4. Through the summer many young birds were seen at the Lake Rosabelle camp, one pair regularly bringing their brood to the tent door to feed on the oatmeal largess scattered for them and for the Longspurs and Horned Larks. The species was common until September 15, after which date a few were seen, the last being noted on September 30.

In 1931 the species was first seen on May 27, when several were heard singing. On June 5 a female was noted building her nest. On June 14 a nest with four eggs and another just ready for eggs were found. From this date on nests were found almost every day.

Though both *Z. l. gambeli* and *Z. l. leucophrys* occur at Churchill, a study of them leaves the question of the proper status of the forms even more uncertain than before. We have under examination twenty-two adult-plumaged specimens besides others in various stages of juvenility, all taken in the three seasons of collection at Churchill. Of these, thirteen are unmistakably typical *gambeli*, with white superciliary line continuous with the light gray lores. Three are equally typical *leucophrys*, with superciliary line ceasing abruptly over the eye and the lores solid black. Six may be described as being of the *gambeli* type, but with the superciliary line separated from the light colored lores by a narrow black bar from the anterior corner of the eye to the black forehead. These have every appearance of intergradation between the two forms and might be so regarded did not the examination of a larger series of specimens indicate that birds of this type show a wider distribution than any zone of contact that can be postulated for the two geographical races. That this scattering of intermediate specimens is not the result of migrational wandering is indicated by a summer specimen taken June 2 near the Moisie River, north shore of the Gulf of St. Lawrence, and a breeding bird taken with nest and eggs on Great Mecattina Island on the same coast. A study of a continent-wide series of 145 adult specimens shows the distinctly western distribution of *gambeli* and the definitely eastern distribution of *leucophrys*, no typical example of *gambeli* being represented east of Manitoba and no typical *leucophrys* from British Columbia. The above intermediate type is common wherever *leucophrys* occurs, though it is rare or absent where *gambeli* is predominant. It is therefore impossible to consider the extreme eastern Canadian Labrador bird as either a hybrid or an intergrade with *gambeli*, and the conclusion is forced upon the senior author that this intermediate appearing type is an extreme variant within the limits of *leucophrys*, and that it cannot be taken as proof of intergradation with another form. Whether *gambeli* is to be regarded as a full species or not yet remains for demonstration.

Unfortunately, though the species breeds commonly at Churchill, where all three of these types occur throughout the nesting-season, we have no direct data on their breeding-relation with each other, nor do we know whether or how they cross-mate, or if any distinction can be made between them according to habitat.

136. **Zonotrichia albicollis** (Gmelin). WHITE-THROATED SPARROW.

Probably a casual summer visitor from the timbered interior. Clarke (1890) records an adult pair of White-throated Sparrows taken at Churchill before 1845.

In 1930 one individual was taken on a cold raw day, June 9, in the friendly shelter of the rocky buttresses behind the Hudson's Bay Company offices near the townsite camp.

137. **Passerella iliaca** (Merrem). FOX SPARROW.

Rather rare summer resident, nesting in the spruce "bush." In 1930 a bird seen at Mosquito Point on June 13 was tentatively referred to this species, but it was not until June 17 that the species was taken and positively identified. A juvenile of the year with ungranulated skull was taken on July 25, and others were noted or taken on August 2, and September 3, 5, and 6.

In 1931 the species was first noted on May 30, when Lloyd took a singing male at the river-mouth not far from camp. On June 4 two pairs were seen and a male collected. On June 11 at least three pairs were observed. On June 15 Sutton collected a nest with four eggs and the parent birds. The species was also recorded at Button Bay on June 26, and at Mosquito Point on June 29.

Specimens taken are all of the eastern race, *P. i. iliaca.*

138. **Melospiza lincolni** (Audubon). LINCOLN'S SPARROW.

Found throughout the summer; it is uncommon, but probably nests. On June 15, 1931, Lloyd took a singing male with much enlarged gonads at the edge of the bush back from the river-bank at about Mile 506, and on June 27 Sutton collected a worn male that was not singing. The species was recorded again on July 3, when one was heard and seen in the Landing Lake District.

The two specimens taken are referable to the eastern race, *M. l. lincolni.*

139. **Melospiza georgiana** (Latham). SWAMP SPARROW.

On May 27, 1931, Lloyd and Sutton collected a male Swamp Sparrow which was frequenting some stunted spruce trees along the river-bank in company with Tree Sparrows.

140. **Calcarius lapponicus** (Linnaeus). LAPLAND LONGSPUR.

Probably the most abundant and generally distributed nesting bird of the region; abundant also as a transient.

In 1930 the species was present in considerable numbers on May 25. During spring and early summer the birds fed largely at the pond- and slough-edges, wading about in a very un-sparrowlike manner. Many times they were seen belly-deep in the water along with Least, Semipalmated, and Stilt Sandpipers when, from a distance, it was difficult to tell waders from longspurs. They were accompanied by Snow Buntings, but the latter never went into the water, keeping to the bunch grass and drier places. Longspurs remained in fairly constant numbers throughout the season to the closing of the records on October 4. About September 5 there seemed to be an influx of transients, but these immediately passed.

In 1931 the species arrived shortly prior to May 25, on which date many singing males but no females were seen. On the following day a few females appeared. Nest-building was first observed on June 1, the first egg on June 5, and the first full set on June 11. Before the termination of the season's work at least a hundred nests must have been found.

141. **Calcarius pictus** (Swainson). SMITH'S LONGSPUR.

Summer resident; nests commonly but somewhat locally. Nests are to be found in the open tundra in almost the same sort of place as that selected by the abundant Lapland Longspur; but the favorite nesting-grounds are the strips of somewhat sheltered tundra extending between and among the tongues of spruce bush.

In 1930 the species was first observed on May 31. Most individuals departed for the south from August 15 to 18, after which date two were noted on August 29 and one on September 3.

In 1931 the first Smith's Longspurs, three males and one female, were noted on June 4. The species evidently arrived a little later than the Lapland Longspur. On June 22 the first nest, just ready for eggs, was found, and on June 29 Pettingill took a set of four at Mosquito

Point. Thereafter several nests were found. Sets consisted of three or four eggs.

In 1932 Twomey found nests with five and three eggs respectively on June 22 and 25.

Male birds, when they first arrive, sing brilliantly while perching on mossy hummocks or the tops of stunted spruces, and sometimes even while flying; but they do not, apparently, have a regular flight performance as do both the Lapland Longspur and the Snow Bunting. When the females appear the males fly about in pursuit for a time, but mating is consummated rapidly, and the dull-colored females begin nest-building so quickly that males are nearly always to be seen in little flocks by themselves, roving here and there, singing gaily sometimes actually in a chorus, or flying off high in air giving their strange, *ticking* call-note, which Lloyd likens to the sound produced by winding a cheap watch.

Nests are not very easy to find, for the females incubate closely and the males seem curious and puzzled rather than alarmed or angry when an intruder appears on their nesting-grounds. Since they are inclined to be shy, they may fly straight away and disappear in the distance instead of staying about to scold or warn the female of danger.

Females, in flushing from their nests, characteristically fly off slowly, spreading their tails widely, rather than running away or falling to the ground to feign injury.

142. **Plectrophenax nivalis** (Linnaeus). SNOW BUNTING.

Common transient, probably casual in winter; apparently does not breed.

In 1930 Snow Buntings were very numerous when we arrived on May 26, and were feeding familiarly in company with Horned Larks about the doorsteps and roadways of the townsite. On June 10 their numbers were noticeably reduced and none were seen after June 16. The vanguard of the autumnal migration appeared September 15. The species immediately became common, being noted daily to the close of the record, October 4. Flights must have passed through on September 29 and October 2, for 100 and 500 individuals are listed respectively for those days. Lloyd noted "an odd Snow Bunting about" as late as November 2.

In 1931, when Lloyd reached Churchill on May 18, he found the species fairly common in flocks along the shore of the Bay and the river-bank. By May 25 numbers of the birds were to be seen about the townsite, and the species was recorded practically every day thereafter until almost the last of June, sometimes one or two birds being observed, sometimes hundreds in large flocks. It was last noted on June 26, when a single male was seen.

In 1932 Twomey noted the last flock on June 12 and the last individual on June 20. In 1933 he took a male on July 23.

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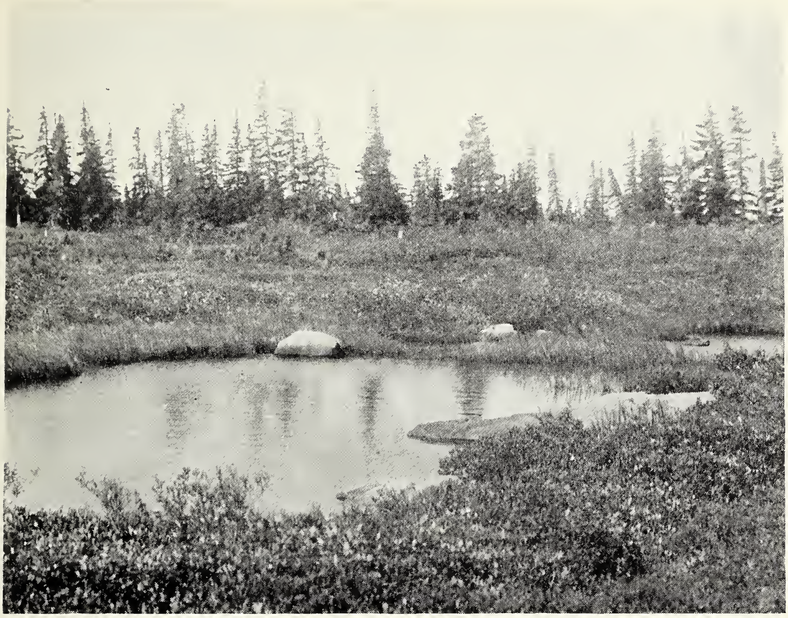
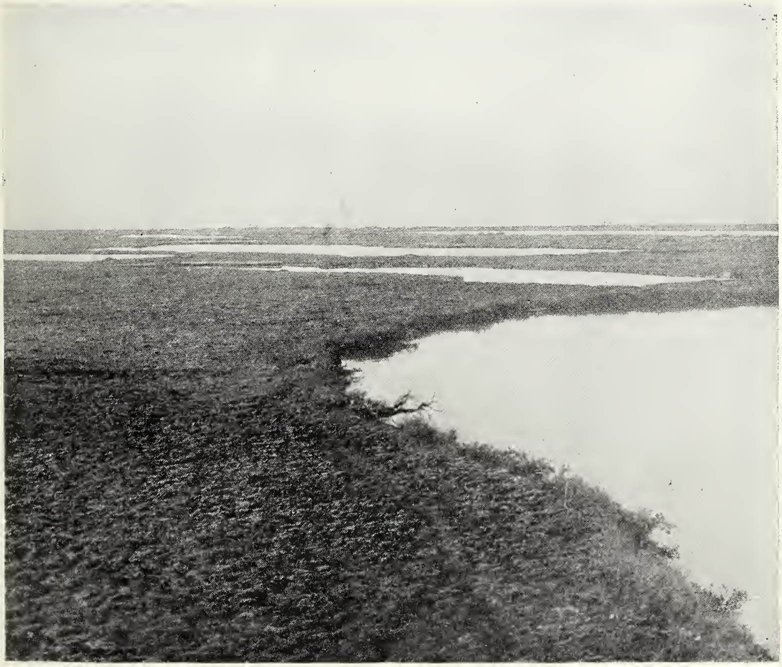
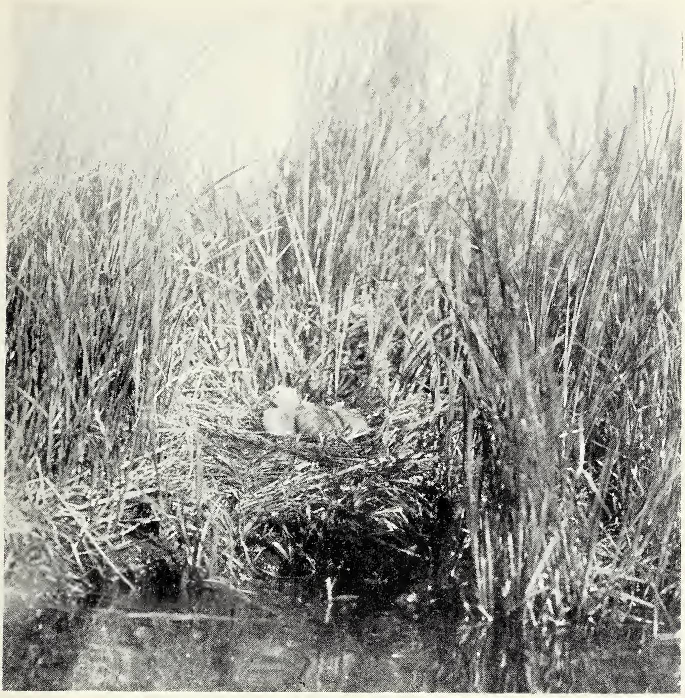


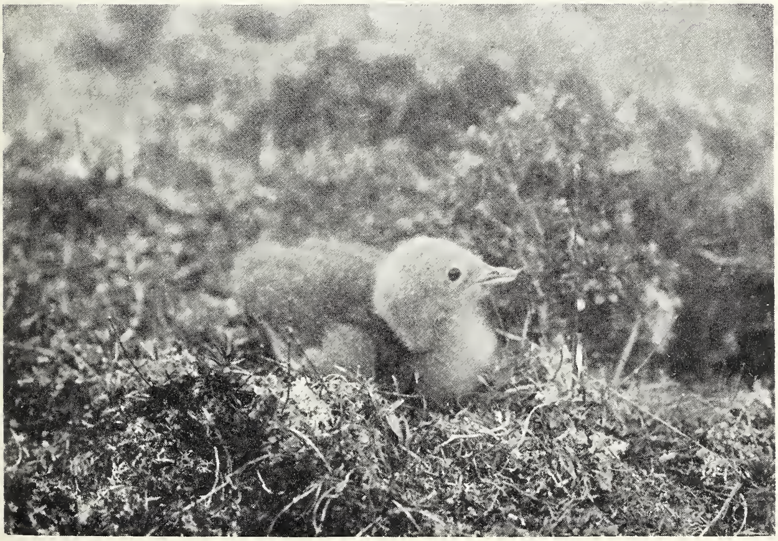
Spruce Forest and Muskeg Pool near Mosquito Point.
Photograph by Percy A. Taverner.



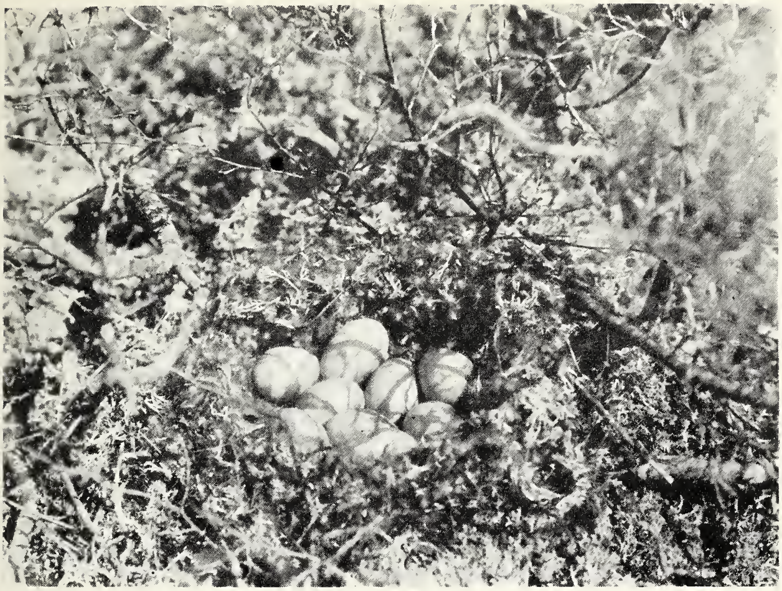
Lake Rosabelle and adjoining tundra lakes, showing characteristic Shore Lines.
Photograph by Percy A. Taverner.



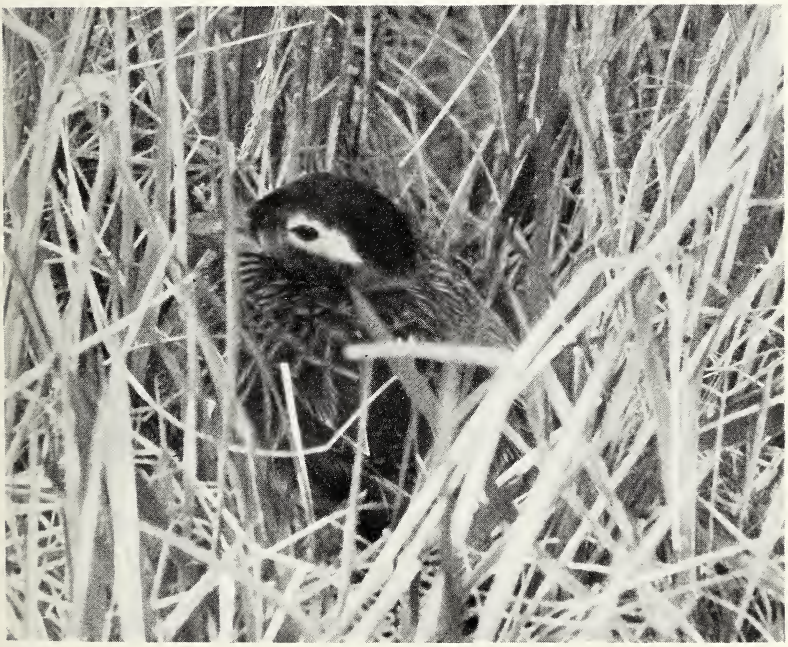
Nest and young of Arctic Loon.
Photograph by Percy A. Taverner.



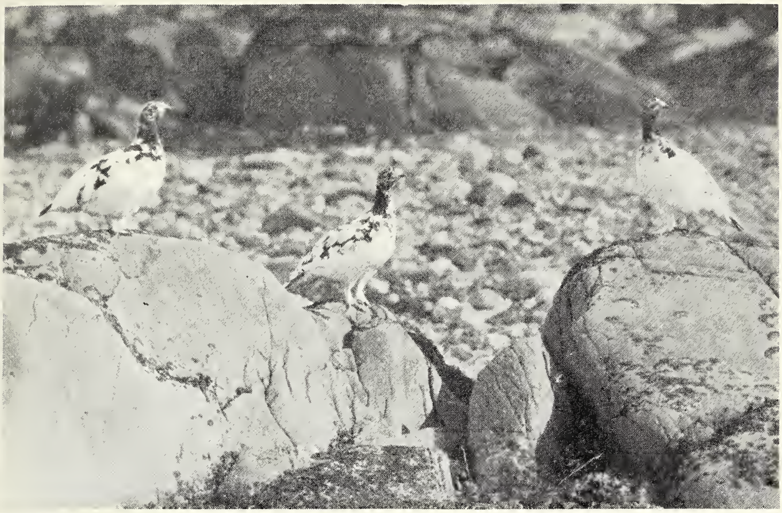
Downy young of Arctic Loon removed from nest.
Photograph by Percy A. Taverner.



Nest of Pintail, June 14, 1931.
Photograph by Olin Sewall Pettingill, Jr.

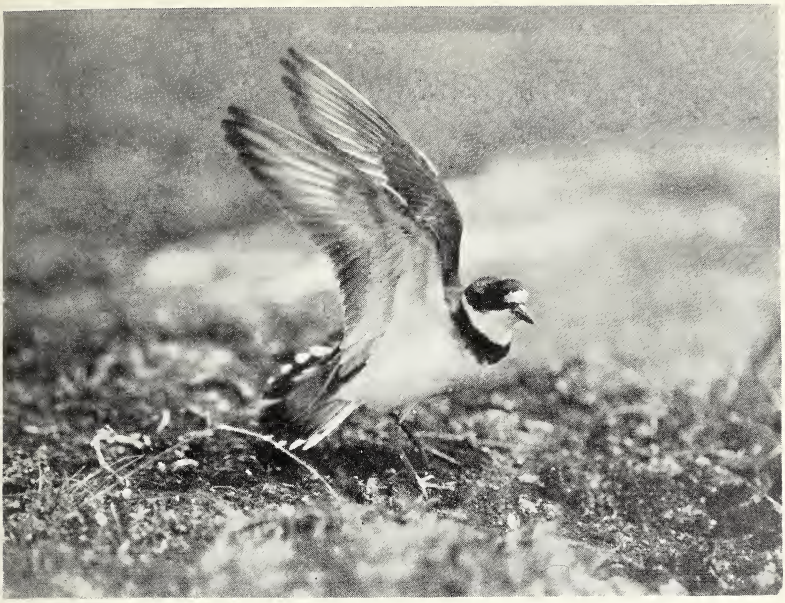


Old-Squaw on nest, July 4, 1933.
Photograph by Miss Marguerite Heydweiller.

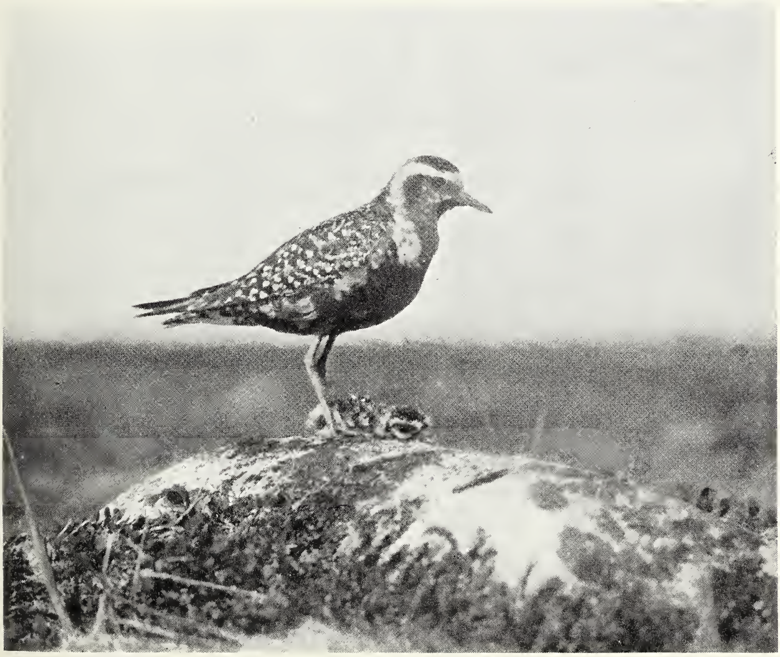


Willow Ptarmigan in changing plumage, May 30, 1931.
Photograph by Olin Sewall Pettingill, Jr.

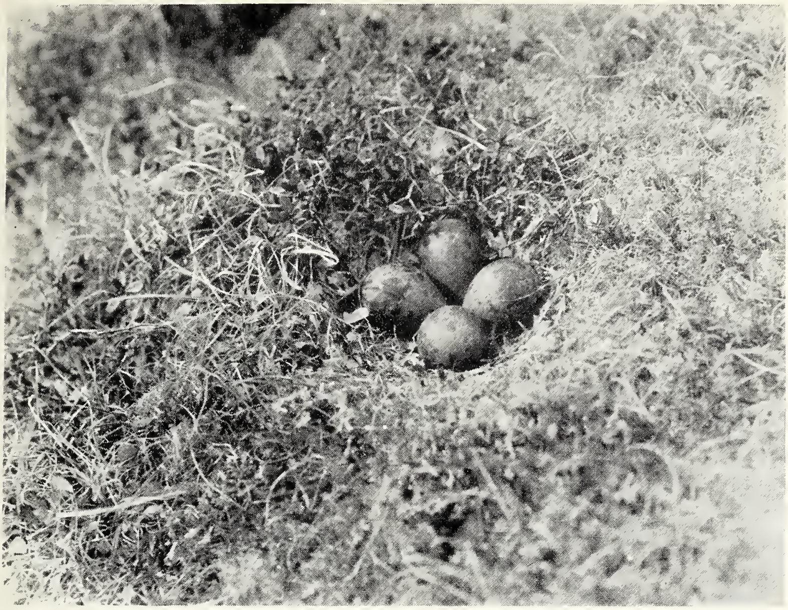
Rock Ptarmigan in winter plumage, May 30, 1931.
Photograph by Olin Sewall Pettingill, Jr.



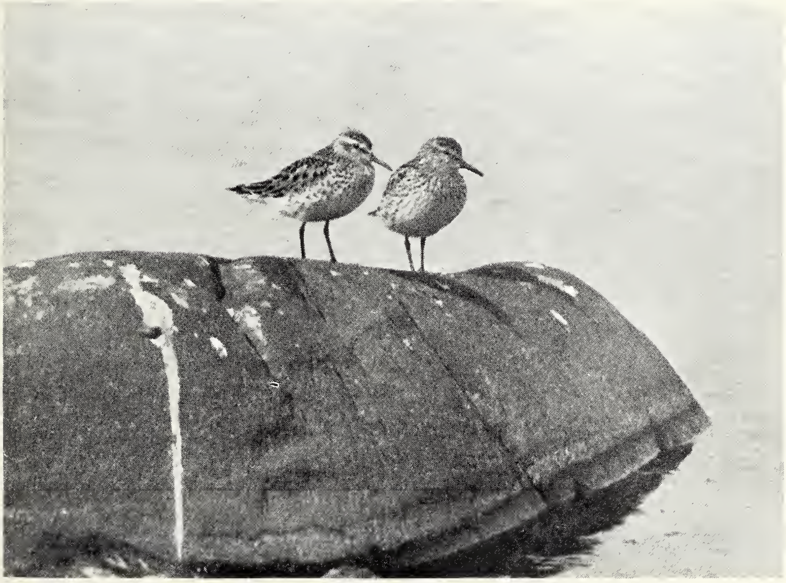
Semipalmated Plover.
Photograph by Olin Sewall Pettingill, Jr.



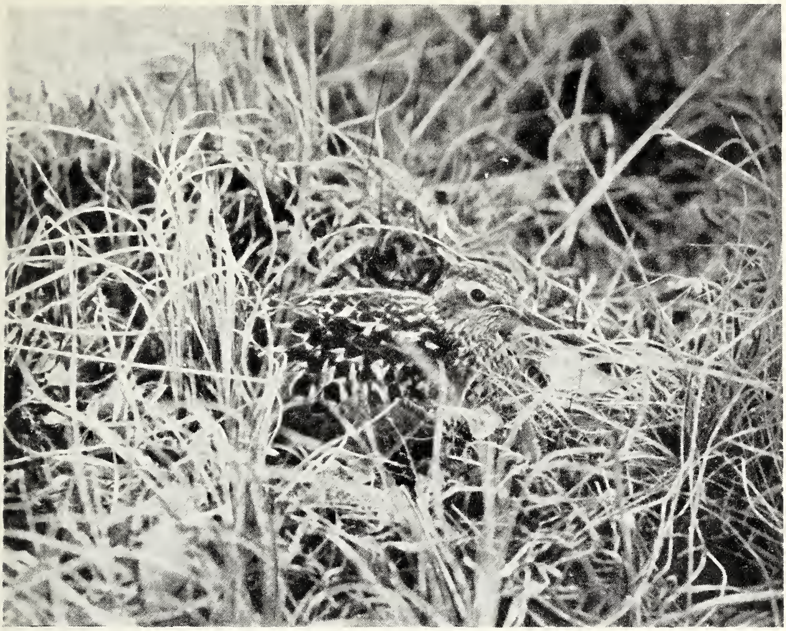
Golden Plover and downy young.
Photograph by Percy A. Taverner.



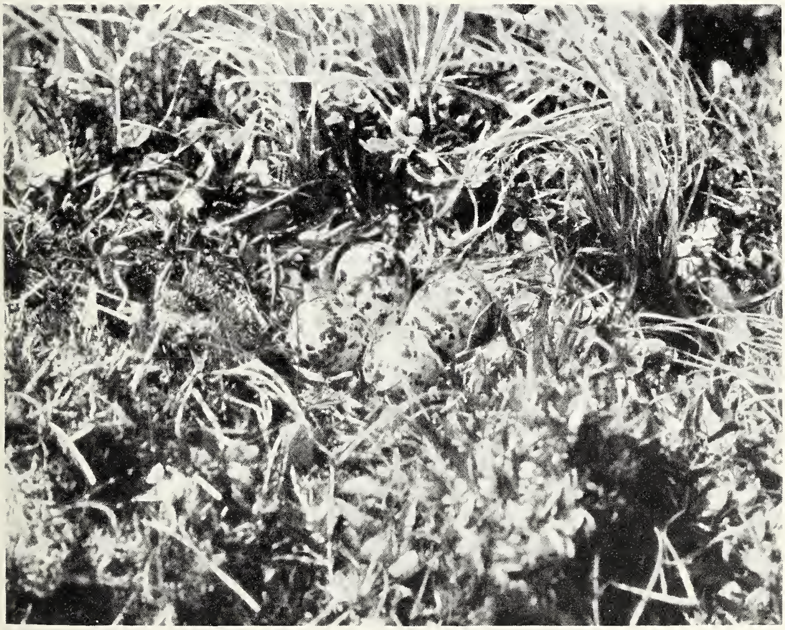
Nest of Hudsonian Curlew, June 23, 1931.
Photograph by Olin Sewall Pettingill, Jr.



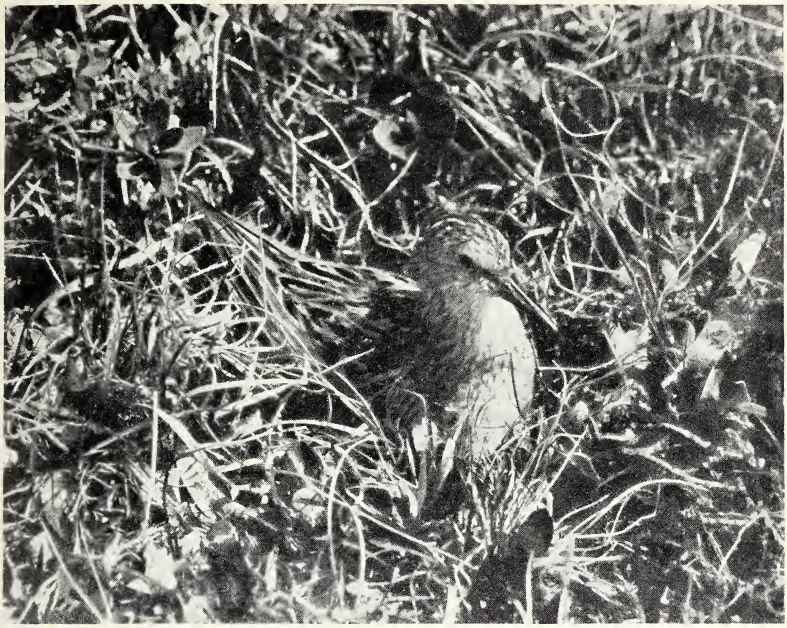
White-rumped Sandpipers.
Photograph by Percy A. Taverner.



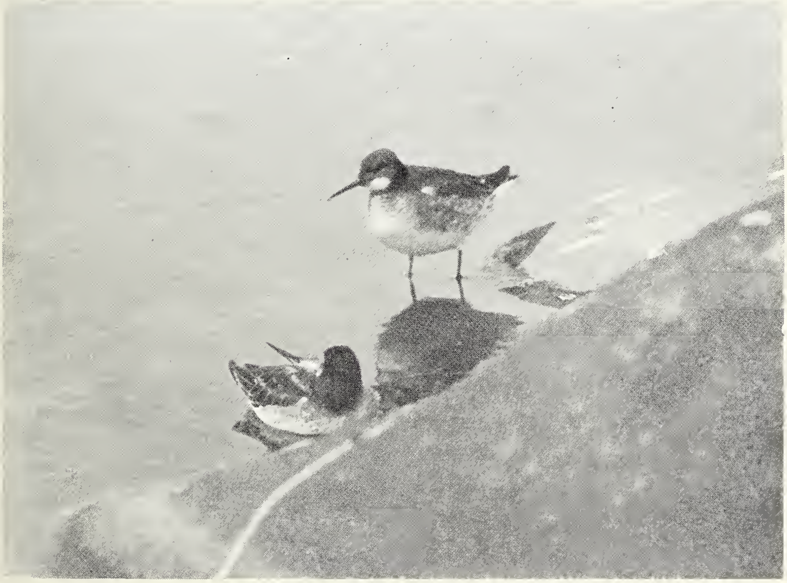
Stilt Sandpiper on nest, June 19, 1933.
Photograph by Miss Marguerite Heydweiller.



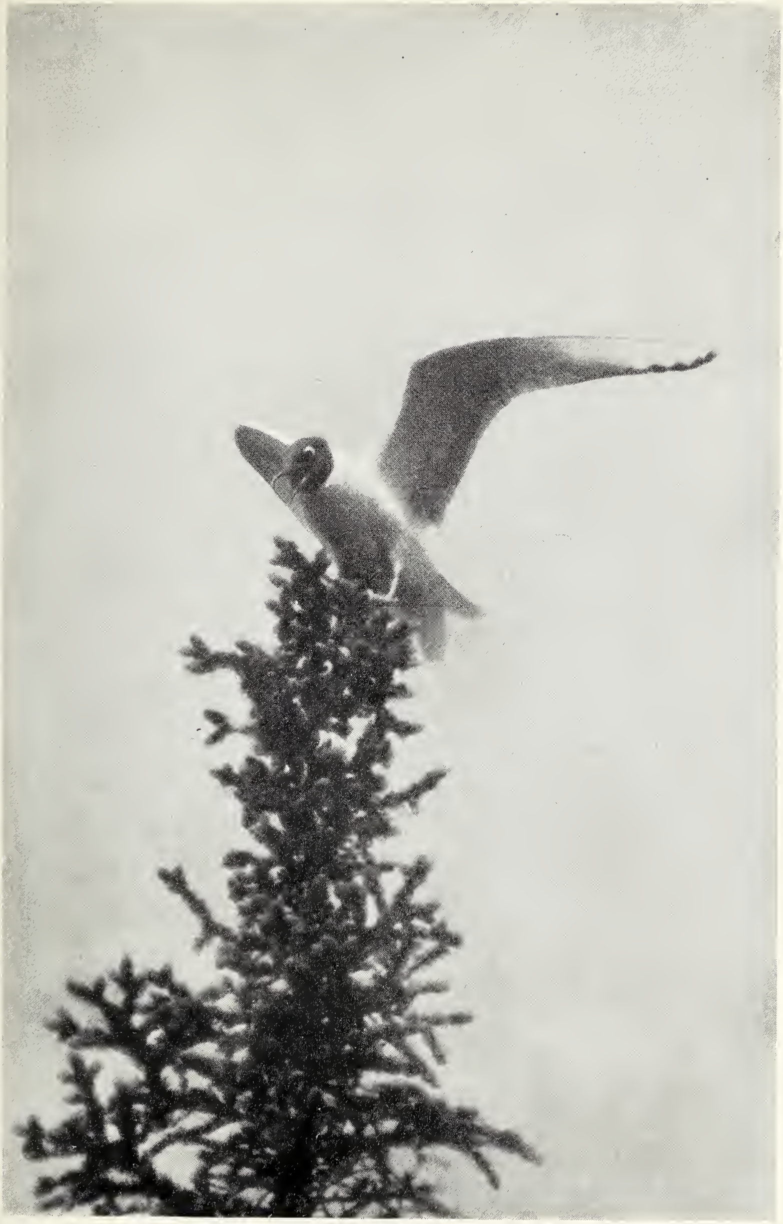
Nest of Stilt Sandpiper, June 21, 1931.
Photograph by Olin Sewall Pettingill, Jr.



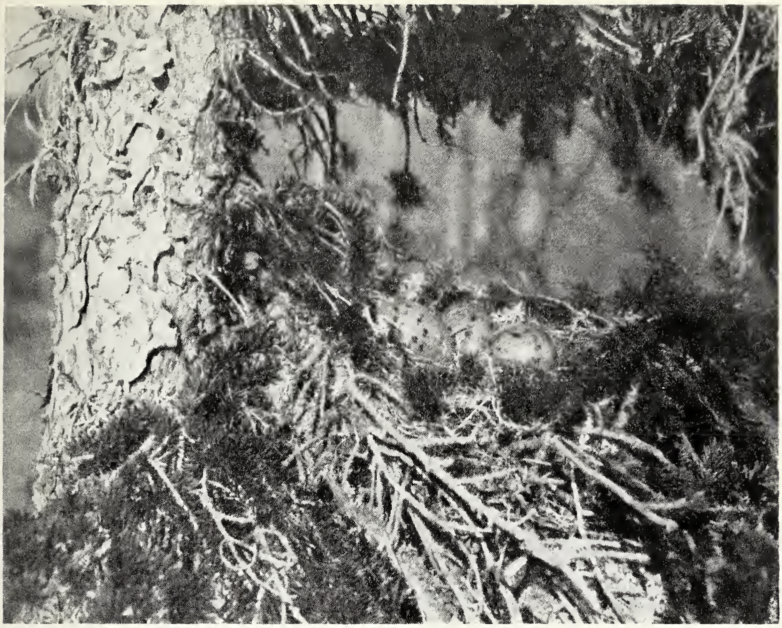
Semipalmated Sandpiper on nest, June 30, 1933.
Photograph by Miss Marguerite Heydweiller.



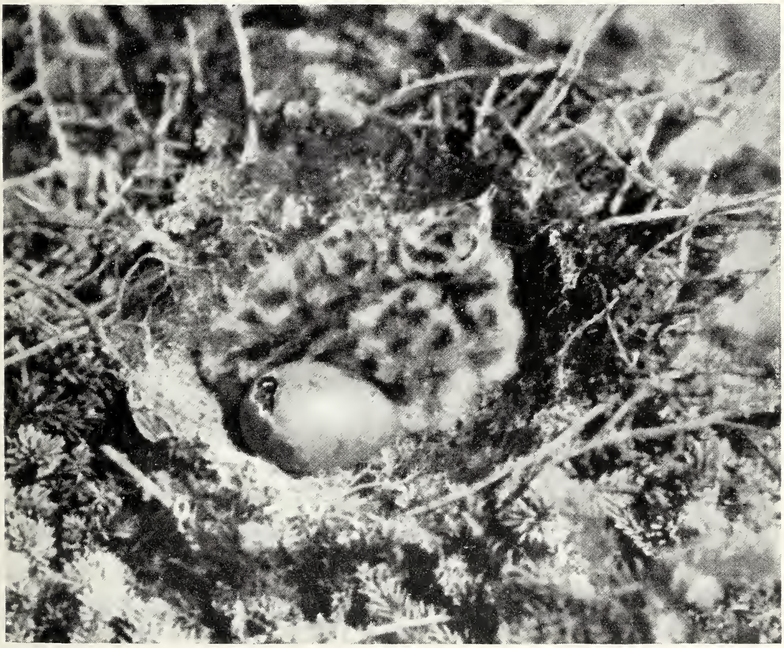
A pair of Northern Phalaropes (female above).
Photograph by Percy A. Taverner.



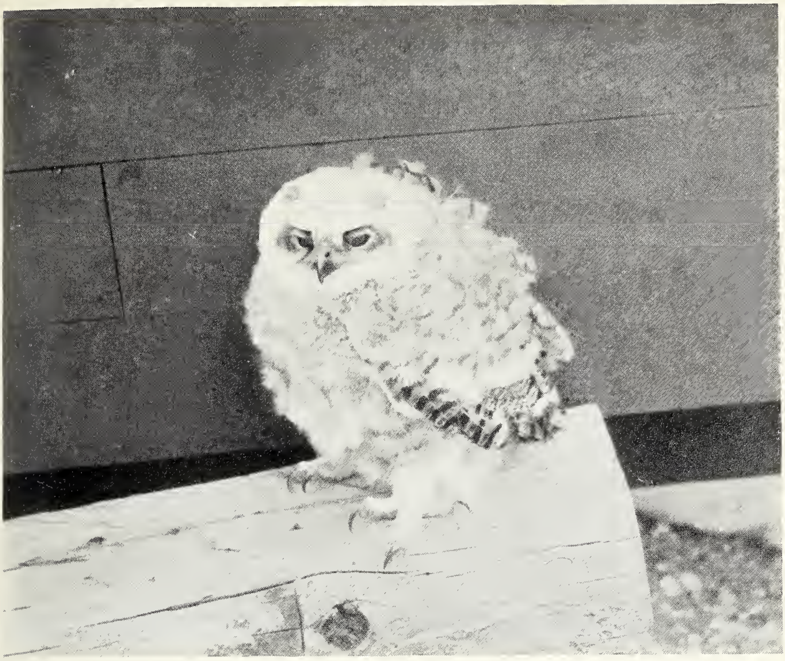
Bonaparte's Gull scolding from top of Spruce near nest.
Photograph by Olin Sewall Pettingill, Jr.



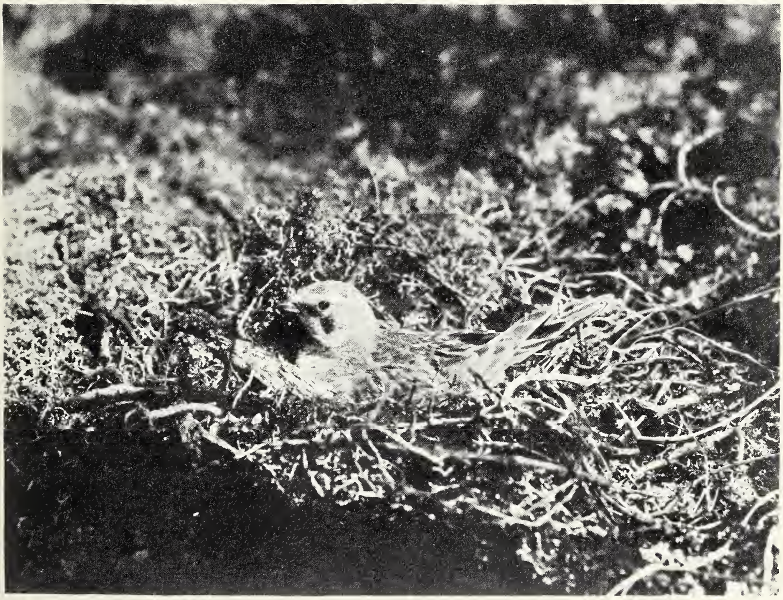
Nest and eggs of Bonaparte's Gull, June 22, 1933.
Photograph by Miss Marguerite Heydweiller.



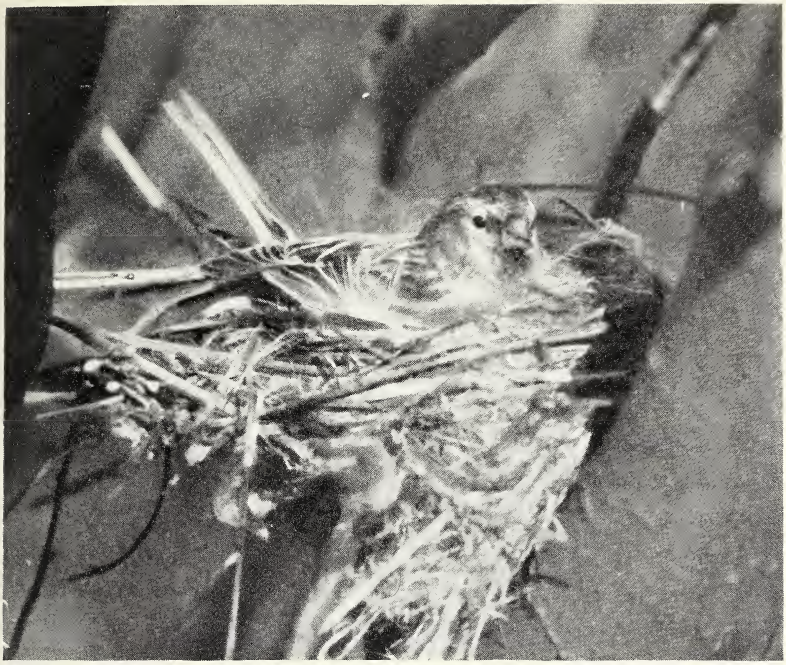
Nest, egg, and young of Bonaparte's Gull, July 11, 1931.
Photograph by Olin Sewall Pettingill, Jr.



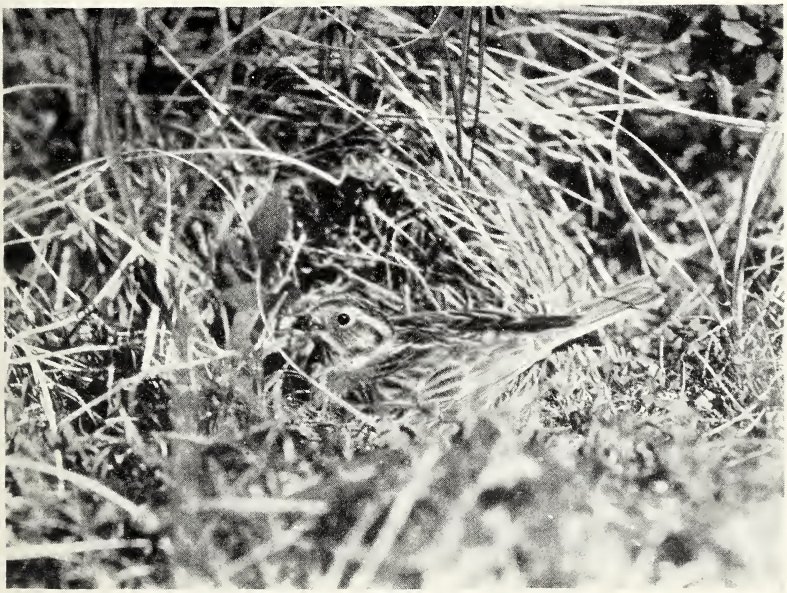
Young Arctic Horned Owl, June 8, 1933.
Photograph by Miss Marguerite Heydweiller.



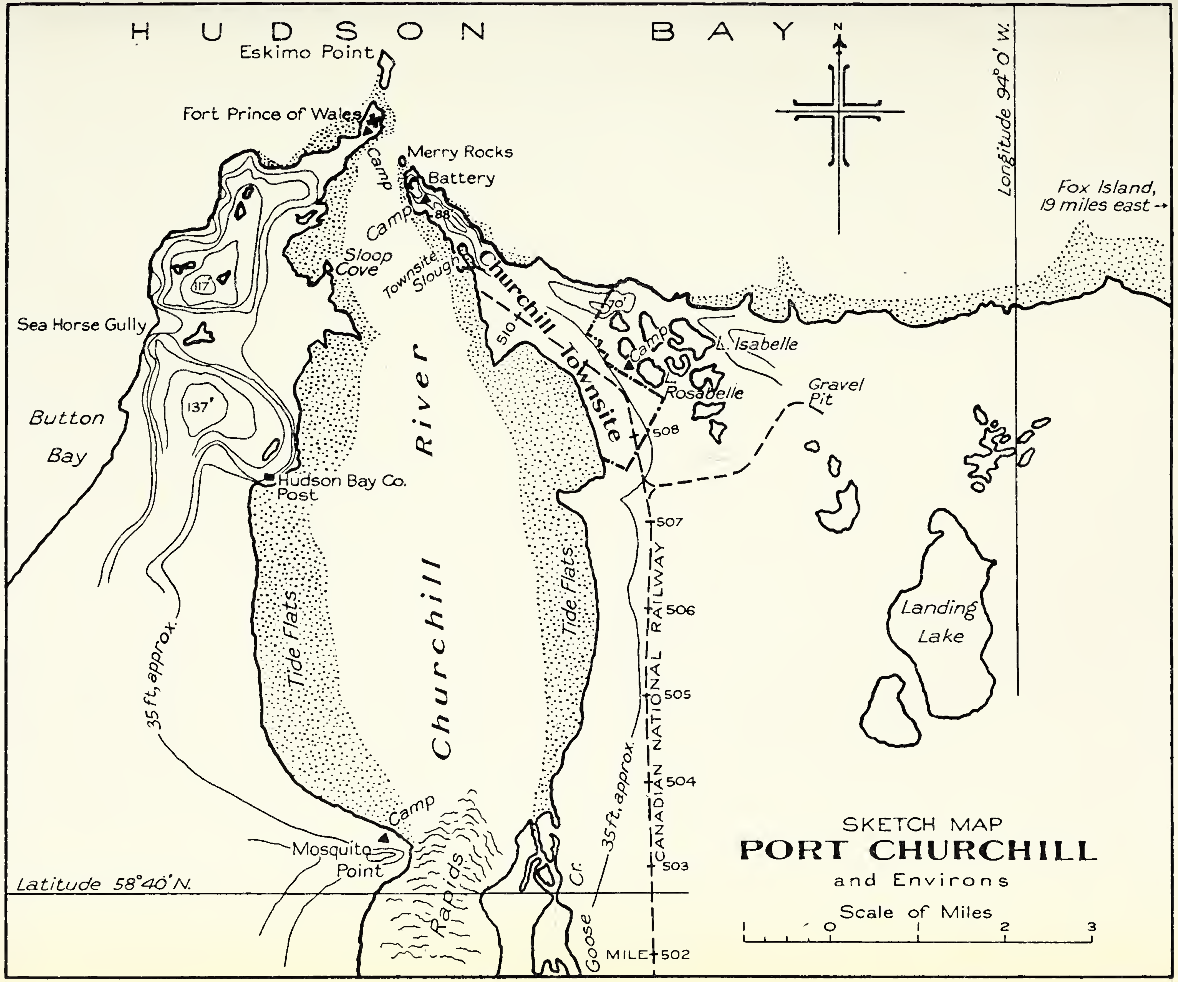
Hoyt's Horned Lark on nest, June 21, 1931.
Photograph by Olin Sewall Pettingill, Jr.



Hoary Redpoll on nest, June 22, 1931.
Photograph by Olin Sewall Pettingill, Jr.



Smith's Longspur at nest, July 9, 1931.
Photograph by Olin Sewall Pettingill, Jr.


SKETCH MAP
PORT CHURCHILL
and Environs
Scale of Miles
0
1
2
3
HUDSON BAY
N
Eskimo Point
Fort Prince of Wales
Camp
Merry Rocks
Battery
88
Camp
Sloop Cove
Townsite Slough
Churchill
Townsite
510
70'
Camp
L. Isabelle
L. Rosabelle
Gravel Pit
508
507
506
505
504
503
MILE 502
CANADIAN NATIONAL RAILWAY
Longitude 94°0' W.
Fox Island, 19 miles east →
Landing Lake
Sea Horse Gully
117'
137'
Button Bay
Hudson Bay Co. Post
River
Churchill
Tide Flats
Tide Flats
35 ft, approx.
35 ft, approx.
Camp
Mosquito Point
Rapids
Goose Cr.
Latitude 58°40' N.

II. THE LIFE HISTORY OF THE RUFESCENT WOODCHUCK, *MARMOTA MONAX RUFESCENS* HOWELL.

By W. J. Hamilton Jr.

CONTENTS

PAGE
Introduction.. 87
Acknowledgments.. 88
Rearing Enclosures.. 88
Present and Former Status of Abundance.............. 90
Habitat Relationship.. 90
Numbers.. 91
Means of Detecting Presence.. 93
Individual Characteristics.. 94
  Intelligence.. 94
  Vitality.. 94
  Courage.. 95
  Sociability.. 95
  Length of Life.. 97
Voice and other Means of Communication.............. 97
Movements.. 99
  Speed.. 99
  Swimming.. 100
  Digging.. 100
  Climbing.. 101
Period of Activity.. 102
Home Range.. 108
Sanitation.. 109
Reproduction.. 110
  Gestation Period.. 110
  Female During Pregnancy.. 111
  Number of Young.. 112
  Time of Birth.. 113
  Development of Embryos.. 114
  Description of Young.. 115
  Nursing Period.. 118

Issued July 5, 1934.

- Development of Young during First Season ... 119
- Relation of Father to Family ... 121
- Rivalry among Males ... 122
- Age of Sexual Maturity ... 123

BURROW AND NEST ... 125

OTHER OCCUPANTS OF WOODCHUCK BURROWS ... 131

MEASUREMENTS ... 133

WEIGHTS ... 134

COLORATION ... 136

MALOCCLUSION ... 138

POLYMASTISM ... 139

MOLT ... 139

FOOD AND FEEDING HABITS ... 141
- List of Foods ... 142
- Amount of Food Eaten ... 145
- Time and Manner of Eating ... 146

ENEMIES ... 146

HIBERNATION ... 149
- Causes of Hibernation ... 150
- Period of Entrance ... 151
- Period of Emergence ... 153
- Condition of Animal during Hibernation ... 154
- Loss of Weight ... 155
- Site of Hibernating Den ... 156
- Incompleteness of Torpidity ... 157
- Other Animals associated with Hibernating Woodchuck ... 159

ECONOMIC IMPORTANCE ... 159

CONTROL METHODS ... 163

REFERENCES TO LITERATURE ... 165

PLATES ... 168–178

INTRODUCTION

American naturalists have written many volumes on exotic forms. They have added to our knowledge of the habits of many foreign species which have never crossed our borders. They have travelled far, often at great expense and considerable hardship.

Or, within our borders, they have made our scarcer American mammals the main source of their monographic studies. In scientific journals they have given detailed observations and enlightening accounts of our lesser known beasts, forms mainly outside the ken of the layman. The American mammalogists have to confess amazing lack of knowledge of the life histories and activities of some of our most common mammals. These forms, by their very abundance, might give us, with hard work, our most thorough going studies. Has familiarity bred contempt, has abundance dulled interest, has constant presence produced casual accounts?

The woodchuck has been known to science for two hundred and thirty years yet we are still unfamiliar with many of its habits and details of life history.

The common woodchuck (*Marmota monax* group) ranges east to Nova Scotia, south to Georgia, west to Kansas and extends its range northwestward into Alaska, covering an area in excess of two million square miles. It is common over most of its range, even abundant over a great part. In spite of this great range, its large numbers and ease of observation, we still know little of its detailed life activities. In some ways the uncommon *Aplodontia*, restricted in range and relatively few in numbers, is much better known. The mountain beaver has been studied by fewer men, but far more thoroughly than has the groundhog.

Where the woodchuck has become a serious pest, drastic efforts have been used to check its depredations. Have these methods of control always been based on actual facts gleaned from a careful study of the life history of the creature? A thorough search of the literature fails to reveal the most essential facts of the woodchuck's existence, data usually necessary in any successful warfare against an animal. Scientists have not consistently attempted to investigate such pertinent topics as the time spent by the young in the nest, behavior and description of the young prior to their emergence from the burrow, seasonal growth, the listed foods and feeding habit. These are important phases. Without a knowledge of them, we must perforce be limited in our attempt at the control of most mammals.

In spite of this seeming lack of interest in the woodchuck, some writers have contributed in no small way to our knowledge of this rodent. To mention all who have published notes on this animal would be to include a roster of American vertebrate naturalists. To cite a few, Merriam (1884), Seton (1928), Fisher (1893), and Howell (1915) have all contributed to our understanding of the animal.

The present study has been made in the hope of filling in some of the huge gaps that still exist regarding our knowledge of this form; to help complete certain chapters in a life that is in reality little known.

Since 1923 the writer has been in a territory exceptionally favorable for the study of woodchucks, and has gathered notes on these animals every year except in 1926. Most of the observations herein recorded were made in 1931 and 1932.

ACKNOWLEDGMENTS

To Dr. A. H. Wright, for his enthusiastic support and suggestions, I owe much. He has made it possible for me to spend long hours in the field on this particular problem. Edward Drake fed captive animals while the writer was unable to do so, and secured a number of specimens. My wife, Nellie Rightmyer Hamilton, has been invaluable in her hearty cooperation in caring for young animals and in her aid in photography. Dr. Robert Matheson determined the arthropod parasites while Mrs. T. R. Allen of the Botany Department at Cornell University aided me in the determination of several plants.

Finally, to Mr. Harold Rightmyer, I wish to express my deepest gratitude for the part he played in this study. Possessed of uncommon stalking ability and unrivalled marksmanship, he was responsible for over three hundred and fifty of the animals used in this study. Without remuneration of any kind, he repeatedly aided me in the excavation of woodchuck burrows, a thankless job at best. He has spent long hours collecting animals in the field and has aided me materially in the construction of cages suitable for breeding purposes. We have spent many pleasant days afield, constantly searching new covers or exploring the old for the "little red monk of the clover patch."

REARING ENCLOSURES

In 1931 woodchucks were kept in large cages at the Cornell University Insectary. These cages, designed for rearing insects and other work in experimental entomology, are approximately twelve by eight feet, and over ten feet in height. The walls are composed of fly screen, and reinforced in part with hardware cloth. In the bottom, under a layer of several inches of dirt, half-inch poultry wire was laid down. Several such cages were used, and several individuals were lost because of their ability to tear through the sides or bottom of the enclosure. On the floor of the cage, large wooden boxes, with top knocked out and inverted, were placed. The opening was made by the woodchuck, which burrowed through the dirt to gain an entrance.

Inasmuch as these pens lacked the strength necessary to house animals for any length of time, new pens were designed in 1932. Seven were constructed. The wire enclosure, six feet in length, three feet wide and seventeen inches high, was made of specially constructed fox farm wire, No. 11. This had a mesh one by four inches. Some of the wire used had a mesh of one inch. A length of galvanized steel piping, such as is used in furnaces, eight inches in diameter and nineteen inches in length, led from the feeding pen to a hole cut in the side of a large galvanized garbage pail, twenty three inches high and sixteen inches in diameter. This made an effective "burrow" leading from the nest chamber in the pail to the feeding enclosure outside.

The lid of the pail was kept securely in place by a piece of heavy wire, securely fastened to one handle of the pail, and run through the handle on the top, then fastened to the other side by a stout swivel snap. (Plate XVII). This allowed easy access to the nest chamber in a moment's time. The whole apparatus was placed in an excavated area in a large straw stack, on a level with the ground. Over the pail, runway, and a foot or two of the feeding enclosure, straw was placed to the depth of a foot or more, depending on the temperature. This gave warmth to the enclosure, which was very necessary when the young commenced to arrive. Temperatures well below freezing were experienced nightly during early April when studies of the young animals were being made.

This description of the pens is given in the hope that a design such as outlined may prove of value in breeding or raising other fossorial animals. It is worthy of note, that in three cages equipped with a length of pipe to simulate the burrow, woodchucks successfully raised their young. In four enclosures without such a tunnel all the young were abandoned shortly after birth, even though the cages were placed in the quiet semi-dark basement of a large barn.

PRESENT AND FORMER STATUS OF ABUNDANCE

There can be little doubt that those who are familiar with woodchucks and their ways, readily believe that the animal yearly becomes more abundant. With settlement, forests are doomed, and with the disappearance of trees come the meadows and pastures. Small wonder that the woodchuck, an uncommon animal at one time, has thrived and multiplied, not in spite of man, but because of him and in all probability will continue to thrive and increase in numbers.

The advent of the high powered rifle, the spread of inexpensive motor cars and the development of improved roads along portions of territory rich in woodchucks had the combined effect of bringing about yearly the untimely death of thousands of woodchucks. This is the case in spite of state laws prohibiting the shooting of firearms from an automobile or from the highway. Woodchucks have become so accustomed to cars, trains, and the like, that they take these as a matter of course. They fear these automotive contrivances but little, if at all. If the animal does take to cover when a car stops, its inquisitive nature usually brings it to the mouth of its burrow to meet its doom.

In spite of this destruction, the ever increasing disappearance of timber, which is replaced in time by fields of clover, alfalfa, truck crops, and hay fields, more than atones for the deadly toll of the sportsmen.

HABITAT RELATIONSHIP

There can exist but little doubt that the woodchuck was once a forest animal and has taken up its abode in open country since the advent of the white man. It has forsaken the heavily wooded areas and lives on that borderline which still supports trees, on the one hand, and wide meadow and pastures on the other. With the clearing of the forest by man, and his consequent extermination of the wolf, cougar, and other large predators of the east, the little "whistle-pig" has multiplied and spread beyond belief. Throughout its range it is today the most abundant animal of its size.

Throughout central New York, a land of mixed hardwoods, rolling pastures, occasional swampy tracts, and numerous streams and lakes, it finds its promised land. Here it occurs in dense woods, bottomlands, and all the rich intervening areas. Woodchucks seem to prefer flat, or slightly rolling land, well studded with rocks or large stones.

In such country the densest population is recorded. In the high bluffs of Kentucky, where soil is at a premium in much of the eastern part of the state, I found woodchucks using the fissures in the rocks for den sites. In eastern Massachusetts, where the soil is remarkably sandy, the burrows were observed to penetrate far deeper than in the region about central New York.

The effect of climatic conditions, such as droughts, mild winters, etc., must play some part in the animal's existence. The late summer of 1931 was noticeably dry, indeed a drought threatened the crops and did considerable damage in central New York. It was noticed, when averaging figures for a study of the rate of growth, that young collected in September of 1931 averaged consistently somewhat lighter than in those animals collected a year later, when copious rains and a good growing season combined to make for rank growth of the food plants commonly used by this species. The average weights of nine young collected during September of 1931 averaged four pounds, nine ounces, while a like number, collected over the same period a year later, averaged five pounds, fourteen ounces.

The nationwide drought of 1930 had little effect on the population of woodchucks in the following year, when they seemed to be more abundant than ever.

Mild winters cause only sporadically a premature awakening of hibernating woodchucks. At the first cold snap they resume their torpor-like sleep.

No definite factor tending to decimate the woodchuck population and to leave them a weak remnant of their former self has yet been noticed to the satisfaction of the author in ten successive years' observation about central New York, whereas Spears maintains the contrary opinion. He said in 1903:

> "Like Rabbits and Hares, woodchucks have years when they are "everywhere," and then follow years of scarcity. Waves of animal life sweep across the foothills of the Adirondacks from time to time... So with the Woodchucks. For a few years they are hardly noticeable anywhere, then some summer, when the grass is mowed, the meadows are alive with them."

NUMBERS

Seton (1929) has gone to some length to point out the probable woodchuck population of New York and New England, on the basis of reports by Merriam and Burroughs. Briefly, he quotes Merriam as capturing 33 woodchucks in one large meadow during a single season. Burroughs and his neighbors accounted for about 200 "chucks" on a hundred acre tract during a single summer. The whole region was similarly populated. This implies 300 to the hundred acre tract, or 2500 to the square mile. Seton, on the basis of these figures attempts to demonstrate that New York and New England, with 100,000 square miles of woodchuck range, should have 200,000,000 woodchucks.

The writer has travelled extensively throughout New York and New England. Notes have been kept on the vertebrates encountered, and during the past year or two, especially on the woodchucks. He considers that Tompkins and Tioga Counties, in central New York, have the richest population he has ever encountered in any area. More than one hundred animals have been seen in an April morning from the road starting three miles east of Ithaca, N. Y., and passing through Brooktondale, Caroline, Richford, and thence to Candor, a distance of approximately seventeen miles. In less than two years, Mr. Harold Rightmyer, Mr. Edward Drake, and the writer have taken considerably over five hundred "chucks," without making any serious depletion of their numbers. The animals were usually sighted from the road, when a little stalking usually brought the observers within their range. In localities especially abounding in woodchucks one can count in a stretch of a mile of road, including two hundred yards to either side, as many as one hundred tenanted burrows. Individual fields will yield a higher percentage, while wooded slopes are not so prolific of dens.

Drake trapped forty-three animals in a period of two years on a tract of twenty acres and made no apparent effect on the number of animals.

In one field consisting of three acres, Rightmyer and the writer counted over thirty separate dens. These were all in use. Another small field less than an acre in extent contained eleven sets of burrows. Throughout this area there must have been five woodchucks to the acre, a much higher percentage than Seton gives, and considerably higher than is to be generally encountered in the area we have under consideration.

There are many extensive areas throughout the state where woodchucks are absent or very scarce. It is unlikely that throughout the state, taking good and bad country together, there is more than one woodchuck to every three acres, and probably there are less than this number. Mr. Harrold Rightmyer, who has hunted woodchucks extensively in the Adirondack region and in central New York, has figured independently that there is one to every two acres. On the basis of our combined estimates, there would exist a "chuck" population of perhaps fifty to the square mile, or between two and three million woodchucks in New York State. There is of course no exact way of determining the numbers, nor does it matter.

So far as it can be ascertained, no plagues, due to the unusual increase or destructiveness of the creature, have ever visited the woodchuck. There is nothing in the woodchuck tribe which parallels the terrific plagues affecting mice and ground squirrels in western America.

MEANS OF DETECTING PRESENCE

Tracks

During late February and March, when the animals are wandering widely, the tracks are often observed on the snow. The four-toed fore foot and slenderer five-toed hind foot serve to distinguish it from the raccoon, which has five prominent toes to each foot. Both fore and hind foot are closely bunched in a running individual and the distance between the sets is normally twelve inches. In a walking animal about four inches separate the tracks.

Feces

It is seldom that the excrement of the woodchuck is encountered about the den, but when it is, the long blackish droppings are not readily confused with those of any other animal. The scats are usually deposited in a dry chamber within the burrow or buried in the mound at the entrance hole, hence are not frequently seen. I once found a dropping thickly studded with the seeds of *Prunus serotina*, but when it was broken up it failed to reveal any insect remains. Had it not been known at the time that woodchucks commonly feed on wild cherries, the dropping might have been mistaken for that of a skunk, for invariably *Mephitis* has insect remains in its droppings.

The scats vary in shape and size, but usually are somewhat long and rounded, or slightly coiled. An inch and a half to three inches is normal, but one very long dropping measured five inches.

BURROWS AND TRAILS

A woodchuck burrow is kept well cleaned out; a fresh mound of dirt at the entrance is usually to be found. We do not expect to find this new earth at the mouth of dens occupied by skunks or rabbits. Likewise the distinct trails through the grass and the closely cropped herbage are sufficient indications of the nearness of woodchucks.

Tooth and claw marks on small trees in early spring, principally about the entrance to dens, are indications of the presence of the woodchuck. The animal scratches the bark from these small trees of the hedgerow. When the incisors are used, they do not make clear tooth marks as do those of mice and rabbits, but leave a ragged appearance to the bark.

INDIVIDUAL CHARACTERISTICS

INTELLIGENCE

The woodchuck, like most other rodents, low in the scale of mammalian life, is not over-endowed with intelligence. Excluding the skunk, there is no other mammal approaching its size that is so readily trapped. An individual will sometimes studiously avoid traps, repeatedly jumping over a pair set in its doorway, but for the most part, these rodents will blunder into any contrivance set for their capture. Woodchucks are easily stalked and shot. When "holed" by man, the animal usually is driven by curiosity to pop out of the burrow to its frequent undoing.

Its strength is great for a small animal. Time and again individuals have pulled out of large steel traps that would easily hold a large dog or raccoon. If not better equipped with physical powers in the spring than the fall, it is certain it can pull itself loose from traps more readily at this period. Yet many woodchucks will not learn to avoid traps, even though they have previously felt the steel jaws a number of times.

VITALITY

So far as I am aware the recuperative powers of a woodchuck are without parallel among the smaller mammals. It is no uncommon experience to collect animals that have a foot missing. I once shot a large male in the late summer whose left fore foot and right hind foot were nothing but black stubs, the whole foot missing at the ankle. Yet the animal was in excellent condition.

Bullets appear to effect them but little, unless it be a head, heart, or lung shot. Even then they sometimes manage to crawl within the den, to die a miserable lingering death in its dark recesses. It is of interest to note that frequently, when an individual is mortally shot, it will drag itself to the entrance burrow a day or two later and die at the mouth of the burrow or on the mound. Animals that are shot in the belly or groin with heavy cartridges which may scatter their viscera widely can run to the den, often fifty yards distance, and make their escape.

Sometimes individuals were collected with huge festering sores, the result of poor marksmanship on the part of a hunter. Again, animals are occasionally met with that have a part of the intestine *hanging from the body*, yet sufficiently healed for them to lead a partially normal existence.

COURAGE

No one can accuse the woodchuck of lacking anything in this respect. His courage is all there is to be desired. I have caught several in the open fields that, when run down, have turned and attempted an attack. Mr. Edward Drake, who once shot a young individual, had the animal run directly at him, chatter its teeth, and drop dead at his feet. They are frequently more than a match for a larger dog, and will soundly trounce a terrier much heavier than themselves.

SOCIABILITY

It has frequently been stated that woodchucks are solitary animals shunning their kind and permitting no other woodchuck to enter their domain. Ernest C. Adams, writing about this creature in "Recreation" for May, 1902, says, "Though a woodchuck may have two or three burrows which he occupies at different times in a year, there is never more than one animal in a burrow, except the mother with her young."

This statement needs considerable qualification. It is true that woodchucks are more frequently solitary in their residence, but it is far from uncommon to see more than one adult in the same hole in times other than the breeding season. There is ample evidence that two, not necessarily a pair, remain together throughout the summer. As a matter of fact, there may be as many as three or four in the hole at the same time.

On May 1, 1931, at Candor, N. Y., I saw three sets of burrows that had a pair of "chucks" to each set. On June 4, 1931, three adult males were collected from the same burrow within a few moments of one another. This set of holes was under observation all the time, and no animals entered while I was collecting the three. On June 11, 1931, Mr. Edward Drake saw two adults at the entrance of their common hole. On August 20, 1932, I saw about twenty "chucks" in the forenoon. Several of these were in pairs at the common entrance hole to a burrow. A week later two "chucks" were seen at a single hole. September 8, 1932, was an ideal day for "chuck" hunting. About thirty animals were observed and three pairs were seen at the common entrance to their hole. During early July of the same year, Mr. Harold Rightmyer took ten woodchucks from one hole in the course of a week's hunting. It is impossible that all were tenanting this burrow at the same time. It was a long established excavation, and probably so attractive to the animals that they kept coming as soon as it was vacated. It might be that several lived in the hole at the same time.

It is certain that they hibernate in pairs at times. Bachman (1846) records that two dormant woodchucks were found in a den opened in early November in Renssaelaer County, N. Y.

Playfulness is frequently exhibited in young animals about the den. I have never observed among older animals any tendency to frolic whereas Gianini (1911) witnessed on one occasion a manner of behavior which could be interpreted as a game of sorts.

It appears so unusual that I quote it in its entirety.

> "On the morning of May 9, while returning home after a tramp in the woods to note the new arrivals in the way of birds, a friend and I suddenly came in sight of a pair of woodchucks at play. We had not yet come out of the edge of the woods, and the animals were at the edge of their burrow in a large meadow some distance away. They would sit up, take hold and wrestle; and we noticed that when one was thrown, he usually landed in the hole and disappeared from sight for a second or two. We watched this performance for a considerable time, and at first thought it accidental when one animal or the other landed in the opening, but it was repeated too many times not to have been intentional.—The woodchucks were probably young of the previous year.—I have watched woodchucks a great deal—but never before have I seen them at play." (Quoted from Seton).

LENGTH OF LIFE

Probably the natural span of life of a woodchuck is four or five years. Mammals supposedly live four or five times as long as the period required to reach sexual maturity. Woodchucks become mature, in many instances, when the animal is in its second spring, or about a year old. I know of no individual of this species that has been kept in captivity for longer than three years. If some individuals attain a weight of over seven pounds the first fall, when they are only five or six months old, it seems probable that the normal life span would not pass beyond the fifth year.

If a few of the marked individuals the writer has liberated when young can be recaptured from time to time, some useful data on this subject may be forthcoming.

VOICE AND OTHER MEANS OF COMMUNICATION

The woodchuck has a well developed voice, that is only heard occasionally or at a very short distance from the animal.

Most familiar is the whistle, common to all marmots. This is a sharp short note, which is preceded by a muffled "phew." This latter note is very low, and one must be close at hand to detect it. The whistle is frequently followed by a rapid warble, which sounds like "tchuck, tchuck, tchuck" and grows fainter at the end. The whistle is usually given in the mouth of the burrow, but may be heard from feeding "chucks" as they sit up to watch their respective domains. The whistle may be of two syllables. Many hunters have told me that once the "chuck" gives this whistle from the burrow, it is useless to wait for a shot at that specimen. This is not always the case, for frequently their curiosity gets the better of them. Cautiously the head is thrust out and finally the animal appears, even though it may have whistled intermittently for three or four minutes.

Once, while hunting "chucks" in the early fall, I heard one whistle. The call was taken up by a succession of "chucks," until five individuals were whistling. They actually made their small field ring with their combined efforts. Young animals develop this note when they are about six weeks old. The call may be heard from a distance of two hundred yards, but it is not so pronounced in the rufescent woodchuck as in the hoary marmot. This latter animal is said to have a whistle which may be heard from a distance of more than a mile

(Howell, 1915). This vocal accomplishment of the woodchuck has earned it the name of "Whistler" in the west, but this appellation is more strictly applied to the Hoary Marmot of the Rockies. The woodchuck is called "Siffleur" by the French Canadians, in allusion to its call.

Another noise, not strictly a note, that is common to all woodchucks, is that made by grinding the cheek teeth together. This grating noise may be heard at the age of four weeks and ostensibly denotes anger or fear. It is a very pronounced, albeit not a loud, noise.

A muffled bark, not unlike that of a small dog, was emitted by captive animals.

EMISSION OF GLANDULAR SECRETIONS

Lying just within the vent are three white-capped orifices, opening into the three anal glands. Within these are housed the secreting cells that give to the woodchuck its peculiar and characteristic odor. In anger or fear, these caps are everted, and the specific odor may be detected. When one picks up a woodchuck by the tail, the odor is frequently pronounced.

Probably the most important function of these glands is their use as a means of communication. On August 30, 1932, while I lay at the edge of a large clover field in the gathering dusk, waiting for the animals to make their appearance, I was suddenly struck by the pronounced odor that assailed me. This was the familiar smell always associated with woodchucks. Simultaneously three animals appeared, all within a distance of fifty yards of one another, and stood for a moment at the entrance to their burrows. Soon several more made their appearance, preceded by the characteristic odor. I spoke to my companion, asking if he had noticed the smell. He replied in the affirmative and further stated that he had noticed this not infrequently, but more especially when he had waited for some time for the "chucks" to commence foraging. In every instance the release of the odor was the signal for the appearance of two or more "chucks." I had never noticed this smell so pronounced, but possibly a combination of wind and atmospheric conditions made the observation possible at the time. In all likelihood this observation could be duplicated any evening in territory rich in woodchucks providing the elements were propitious.

It is unlikely that marmots have "odor posts," so common with members of the Canidae. At any rate, I have never seen any instance of such. It is frequently an easy matter to determine the presence of woodchucks in a burrow simply by the characteristic smell.

MOVEMENTS

When not alarmed, the normal gait of the woodchuck is a slow walk. It frequently stops to examine a tender shoot, or sits up on its haunches to scan the field for foes. When alarmed, the woodchuck's movements are hasty, and consist of either a fast walk or a loping gallop, which take it over the ground at a surprising speed for such an apparently clumsy creature.

Speed

On a number of trips afield I have had the speed of frightened woodchucks well demonstrated, as they ran for their holes. Once I chased a feeding woodchuck that had wandered eighty yards from its burrow. I had just fired at the animal and missed; and knowing there was no hole nearer than the one it had started for, I started in pursuit. The animal had about a fifty yard start, and managed to keep that lead throughout the chase, although I tried desperately to overtake it. Assuming that it took me about fifteen seconds to cover the eighty yards, the animal had averaged then ten miles per hour in its dash for safety. This is perhaps an excessive speed, and could be maintained for a minute perhaps, but surely not for a longer period. I have never seen one run faster.

A number have been run to earth in the field and captured. When capture is imminent, the fearless creature will often turn on its tormentor and show fight. I have seen dogs turned back by this show of courage, and most every farm boy who owns a mongrel dog has noted the same spirit on the part of the woodchuck.

Early in the spring of 1931, a large woodchuck was observed pursuing a smaller individual. They were moving at a fast rate and were probably equalling the best efforts of an average man over rough ground.

Woodchucks do not have the endurance for long trips at high speed. The animals do make extensive treks in the early spring, but the tell-tale tracks in the snow show that they seldom run at this time.

SWIMMING

Woodchucks, like all other mammals that have not assumed the upright posture, are good swimmers. It is amply testified by many writers that they enter the water of their own accord. The most remarkable instance of this character is recorded by Robinson (1923), who says:

> "In front of my home in Nelson County, Virginia, the James River is over 100 yards wide, and, at that particular spot, the river bottom is all on the north side, the south side being a precipitous, rocky bluff. In this bluff, there are a number of woodchucks; but the vegetation . . . does not furnish them with a food supply comparable to that on the cultivated land on the opposite side. They, therefore, frequently swim across, feed on corn, clover, melons, etc., and then swim back. I have several times seen them do this; and on June 18, 1899, I overtook one with a boat and captured it in the middle of the river."

I once shot at a "chuck" near Locke, N. Y., during mid-June. The animal had been feeding in a marshy tract bordering a stream, twelve feet in width and knee deep in depth. Without any hesitancy, the animal ran into the water and swam to the other side. So alarmed was it that it did not waste any time but, in a hasty retreat, disappeared in the brush on the opposite shore.

DIGGING

The woodchuck is a digger *par excellence.* His stout fore paws, armed with strong black claws, enable him, in soft ground, to keep well ahead of an ambitious digger for some little time, inasmuch as his custom is to fill in behind him, when pursued. The excavations by this animal are accomplished with powerful alternate strokes of the fore feet. The stout skull is an important tool of the animal while digging, as comparison with a skunk would indicate. An adult woodchuck's skull weighs about forty grams; a skunk with the same body weight and of nearly equal size has a skull weighing one half that of the rodent. Yet the skunk has a brain capacity equal to that of the "chuck." In other words, with strictly fossorial animals or those that do a considerable amount of digging, the skull is heavier and more massive than in those that do not dig, or burrow but little.

It long puzzled the writer how the animal could bring to the surface, from the innermost chambers and ramifications of its burrow, stones weighing more than two pounds and perhaps several hundred pounds of dirt, in the larger excavations. I am not at all sure of the method yet, but observations on numerous animals working at the entrance have clearly demonstrated a few facts. Woodchucks employ the head, but more especially the facial region, to remove the larger stones from the chamber. Certainly the hind feet, which are noticeably less strong than the fore legs, are yet stout enough to push backward and out any loose dirt that accumulates here. Possibly this action explains the irregular bare patches on the snout and forehead so frequently encountered in woodchucks. This glabrous area is more common to the females than the males although both sexes engage in the strenuous duties of home building.

TREE CLIMBING WOODCHUCKS

So much has been published of late (Journal of Mammalogy, May and November, 1925) on the woodchuck as a tree climber, that it seems of little value to comment further on this rather common phenomenon. However, my observations may lend some facts of interest to the history of this subject and possibly lay the matter forever at rest.

On April 7, 1924, I was trout fishing near Newfield, N. Y., in a rather dense alder thicket, bordered by large hardwoods on either side. Presently I heard a movement in the thicket and stood still, hoping to discover the cause of the noise. My surprise was great when I saw a good-sized woodchuck climbing a large maple, about fifteen inches through the trunk, perhaps to obtain a better view of the queer biped along the stream. The animal climbed hand over hand, with evident ease. It stopped when about twelve feet from the ground, and below the first limb. After a few moments rest, it commenced to peer about, first to the right, then to the left. I approached it slowly, inadvertently making considerable noise on the way. As soon as it saw my intentions, it "froze" to the trunk of the maple, pressing close and flattening the hairs. "Glued" to this spot, it allowed me to touch it. I then backed away and gave the tree a smart rap with a stick. It fell out of the tree in its haste to get away, and ran off through the woods at a great clip.

On May 12, 1931, at Danby, N. Y., in company with Mr. O. C. Van Hyning, I witnessed a woodchuck leisurely climb a leaning wild cherry tree, to feed on the blossoms. The animal appeared exceptionally tame. Examination of the tree showed the woodchuck had been using it for some time, perhaps as a point of observation as well as a dinner table.

During early September, 1924, I surprised an old woodchuck that was sunning itself in the top of a wild cherry. In its haste to depart, the animal lunged from its perch, about twelve feet from the ground, and quickly disappeared into a nearby hole. Possibly he had been feeding on the ripe fruit, as they are known to do.

It is not an uncommon sight to see the animals perched atop a fence post, surveying their domain. Whether this is done as a protective device, to better scan the fields for enemies, or whether it is a playful habit indulged in, I cannot say.

While driving through western Pennsylvania in early July, 1931, I saw a young woodchuck run across the road. I quickly stopped my car and gave chase. The animal ran through heavy brush, but I slowly overtook it. Sensing ultimate capture, and apparently in a section devoid of accessible holes, it did the next best thing, and ascended a small oak. It climbed to a height of twenty feet or more with remarkable celerity for such a heavy-bodied animal. I attempted to dislodge it without success. Unfortunately time did not permit of further observation to determine the manner of descent, but it is said that they can descend the perpendicular trunks of large trees, head first (Langdon, 1880).

PERIOD OF ACTIVITY

In general, woodchucks are most active outside their burrow during the early morning hours, and again late in the afternoon. They may, however, be observed at any hour, under favorable weather conditions, but show a decided preference for the above periods. Many pages of notes have been accumulated regarding the number of animals observed daily, together with the time spent in the field. This will best be treated by months, as the daily activity apparently changes with the season.

MARCH

Paradoxical as it may appear, records show that the woodchuck is highly nocturnal at this season. During this early period it is likely to be more active in the night than during the day. This is amply recorded by their telltale tracks on the snow, and by their subnivean wanderings. On March 15, 1931, the ground was covered by several inches of snow. I visited a series of woodchuck burrows shortly after daybreak, and the ground was literally covered with their tracks. New tunnels had been opened in the snow, and signs of their wanderings the previous night were everywhere. Yet, the same tract at dusk of the previous day had shown little indication that "chucks" were present. The temperature during the night was well below freezing.

On March 19, 1932, about an inch of snow fell between 5:30 and 8:00 P.M. I placed traps at the entrance to several holes just before dusk and closed several other shafts by stamping that had recently been opened. The traps were visited at 7:30 o'clock on the following morning, when the temperature stood at 20° F. Several hours earlier it was 3° lower, yet a woodchuck was caught in one trap, and several holes, closed tight the previous evening, were opened.

Throughout the 20th, snow flurries fell through the day, with a temperature hovering above the freezing point. Two traps had held "chucks," and I tracked one for a quarter of a mile through the snow. In this trip it had opened, or entered, eight burrows, possibly in the quest for a mate. These holes were situated in a hedgerow of wild cherry (*P. serotina*) and at the entrance of each hole where such young shoots grew, they had been clawed or bitten by the animal.

On March 23, 1932, a female was taken about 6 A. M., and two males at 5 P. M. The temperature at these periods was slightly below freezing. On March 24, 1932, a woodchuck was trapped in a trail leading directly from one set of holes to another. This animal was caught some time before 7 A. M., and after dusk of the previous evening. The temperature averaged well below freezing during the night, and from six inches to a foot of snow covered the ground at the time.

On March 25, 1932, a "chuck" was seen on a snowbank about 5 P. M. Apparently the same individual was recorded an hour earlier by Harold Rightmyer. This same person saw a pair of "chucks" about 5:15 P. M., feeding some distance from their hole. They both entered the same den.

On March 27, 1931, I spent most of the day in the field. Conditions were ideal, with a temperature of 55° F. throughout most of the day, and little wind. A single "chuck" was observed. I passed through territory ideal for observing the woodchuck.

In all likelihood they run as much by night as they do by day during this period.

APRIL

"Chucks" appear on every hand with the coming of the first real warm spell, and show little choice of time for feeding or sunning themselves. They are more likely to be seen during the warmest part of the day.

On April 13, 1932, one animal was seen at dusk. On April 17, 1931, the whole day was spent in the field. The morning was cold, but toward noon it warmed, and the temperature averaged 50°-55° F. throughout most of the afternoon. One hundred and seven woodchucks were seen, and twenty collected. Few were seen before 9 A. M. About half were observed from 10 A.M. until 1 P.M., and the remainder were recorded, rather evenly distributed, from that hour until 5:30 P.M. After this, with a falling temperature, none were noted.

On April 23, 1932, a strong north wind accompanied by slight rains, falling harder at 6 P.M., did not keep "chucks" under cover. From this hour until dark, five were seen.

MAY

During this period "chucks" are still indiscriminate about their feeding periods. In 1931 and 1932, during May, the writer spent approximately one hundred hours in the field, and his companion, Harold Rightmyer, about half that amount. We kept exact notes on the time in the field, weather conditions, number of "chucks" seen, and the period of the day at which they were seen. About six hundred individuals were noted. They were observed equally as often in the morning as in the afternoon, except before storms, when they were much more active and ranged farther from their home burrow.

JUNE

Throughout this month vegetation is making rapid strides, and woodchucks are consequently harder to observe. Toward the latter part of the month, with the longest days of the year at hand, woodchucks were more frequently observed during the twilight hours.

JULY AND AUGUST

During this period it is commoner to see animals about the dens during the early evening than at other hours. However, the prolonged heat waves of July and August apparently affect this animal but little.

July 29, 1931, was extremely hot throughout the day. From 11 A.M. until 12 M. the thermometer registered 91° F. and the sun was very bright. Ten woodchucks were observed feeding during this period.

On August 4, 1931, I concealed myself, well before daylight, in some bushes commanding a good view of a four acre field, in which at least fifteen animals were known to occupy holes. At 5:10 A.M. the first "chuck" made its appearance, and by 6 A.M. another had shown itself. Neither attempted to feed, but sat about the entrance hole for a few minutes, and then disappeared. They could not have been alarmed at my presence, for what little wind there was blew toward me. These were the only "chucks" seen up to 8 A.M., when I left. I had previously seen as many as thirteen "chucks" in this field at one time in the early evening.

Again I secreted myself near a favorite feeding ground of these animals early one morning in August, long before darkness had departed. By 8 A.M. I had seen four animals, yet it was customary to see a score in this area over a two hour period in the late afternoon. However, during a three week period in June, 1932, when I had occasion to pass a strip of good territory between 5:30 and 6 A.M., I was usually rewarded with a sight of one or two animals about the entrance holes to their burrows.

A few hunters maintain that morning shooting is superior to that of the late afternoon. They even claim that more "chucks" are outside of their holes at this time. I cannot agree with these views, but further observations may possibly show them to be quite active at this time. Captive individuals (nine adults) were frequently observed feeding in their cages in the uncertain light that precedes daybreak.

SEPTEMBER

As with the preceding months, woodchucks are more active during the late afternoon than at other periods. On September 6, 1932, I was in the field from 1 P.M. until dark. Two animals were seen before 5 P.M. In the next hour and a half, eighteen were observed. On September 9, 1932, I was in territory abounding in woodchucks from 11 A.M. until 2:30 P.M. Three animals were recorded. The following day my companion and I saw six "chucks" between 3 P.M. and 5 P.M., and thirty-four animals between 5 P.M. and dark. We were in excellent territory for "chucks" during the entire period.

September 16, 1931, was very warm, the temperature reaching 85°

F. at 9 A.M. I watched a large individual sunning itself at noon on this date. The animal appeared dead. Its head was down, the hind legs were spread out, and the fur was blowing in the occasional breeze that fanned it. It made no move in over a half hour while I watched, until I attempted a closer approach, when it slipped into a hole near its snout.

On September 13, 1932, my wife and I closely scrutinized every favorable field for woodchucks from Cazenovia to Albany, N. Y., a distance of over a hundred miles, from 10 A.M. until 3 P.M. While we saw over two hundred sets of burrows, only three woodchucks were observed. The weather was ideal for their appearance.

During late September, woodchucks are becoming scarcer; some have commenced their winter sleep. On September 19, 1931, fifteen "chucks" were seen in a two hour period during the late afternoon. Several, while very much alive, were stretched out prone at the mouth of their burrows, as though dead. September 20, 1932, was a favorable day for their appearance. I saw no "chucks" from 4 P.M. until dark, but on the following day, at 6 A.M., a single individual was seen feeding. The animal remained out of the burrow for more than an hour. None were seen the evening of this day, in spite of excellent weather conditions.

September 27, 1931, was a cold raw day, with temperatures ranging from 52° to 56° F. Three woodchucks were seen in the morning by Harold Rightmyer, and he and I saw three more in the afternoon. Several hard frosts immediately preceded this period.

OCTOBER

On October 3, 1931, Harold Rightmyer collected six of twelve "chucks" he saw. He said they were taken pretty evenly from 9 A.M. to 3 P.M. He supposed that many had retired into their holes for the winter. The burrows that had previously been open and in use, now appeared to have been either deserted or filled with wind blown leaves and debris. This was a warm bright day, with temperatures ranging from 70° to 80° F. Five of the six taken were young of the year.

About a half mile from my home is a large alfalfa field, and in the midst of this land of plenty a woodchuck had made his home during the late summer. I had occasion to pass this field about 7:30 A.M. nearly every day, and sometimes several times a day, and can do no better than to quote directly from my field notes the observations made on this individual.

"October 10, 1931. The 'chuck' in Marion's field was out at least twice today, once in the late morning and again about 5 P.M. Quite cool, wind strong and from the N. W.

"October 13, 1931. A heavy killing frost last night, with the temperature down to 26° F., yet at noon today I saw the 'chuck' in Marion's field. This same animal was out last evening at 5:30 P.M., while a cold wind was blowing.

"October 19, 1931. Again the 'chuck' is at the entrance to the hole at 7:30 A.M., the temperature is down to 28° F., and many previous nights have been as cold.

"October 23, 1931. At 7:30 A.M. I saw the 'chuck' sitting at the entrance to his burrow, and all about him the alfalfa is bent and white with a severe frost.

"October 26, 1931. The 'chuck' out at 1 P.M. Bright sun, no frost last night, but a cold west wind blowing."

This was the latest date the animal was seen. On Christmas, 1931, I excavated the hole, but found no woodchuck; likely he was safely ensconced in a dry cell off from one of the main shafts.

All the foregoing has to do with his feeding hours and sunning periods above ground. What are his habits in the darkened chamber and runways below the surface? Is it in sleep? To students of nature this may possibly be forever a closed chapter in the animal's life. I have tried to estimate this period spent in the burrow or nest.

Two entire days were spent in the field, one in July, another in August, during the season of 1931, watching a field of eleven sets of tenanted "chuck" burrows. Some of these animals were visible for three hours a day; others showed themselves for less than an hour. The period of activity above ground, in the course of a month, may be computed to be approximately ninety hours, with the assumption that a woodchuck stays daily outside the hole for three hours. From the first of April until the last of September, this would make a total of 540 hours. Many woodchucks still remain above ground in October, but they are in the minority. Allowing twenty-five hours as an average for this month and 100 hours for late February and March, we have a grand total of 665 hours. I believe this to be exceptionally high. There are 8760 hours in a year, so the period above ground occupies approximately 12½ per cent of the woodchuck's life. The rest is spent in sleep or partial darkness. Certainly the woodchuck does not sleep twenty-one out of the twenty-four hours in the summer time. Yet he is below ground for that period. What he does during this period is an enigma that cannot readily be solved. There is yet much to be learned regarding the underground habits of all fossorial mammals. It is still a virgin field.

HOME RANGE

A mass of data has been accumulated on the activities of woodchucks about their dens, and much thought given the subject, yet I am not at all certain what amount of ground an average woodchuck will claim as its territorial right. It is not an uncommon sight to see two or three feeding woodchucks within a few feet of one another. One animal may have its home den within a yard or two of its feeding position, while another may have travelled two hundred yards to reach suitable feeding grounds.

In considering the home range, I do not include the early spring *wanderlust* of woodchucks, impelled by the mating urge to wander far in search of a mate. We are concerned here with the normal activities of these animals, from May to early fall.

On April 17, 1931, nearly one hundred woodchucks were seen. Some were one hundred yards from the home den, by actual measurement, and when alarmed passed by several nearby dens to reach their own. When a frightened woodchuck goes into the most convenient hole, and another animal is occupying it, he will quickly be driven out by the rightful tenant, and sent scurrying to his own retreat. Several times during this day of observation woodchucks were alarmed, and put into the wrong hole. They were apparently quickly ousted, and in one instance a "chuck" was pursued by a smaller individual, that chased it into its rightful burrow.

On May 5, 1932, a "chuck" was seen to enter three widely separated sets of holes, during the course of half an hour. It travelled 270 yards in this time, and fed intermittently. This area had a sparse woodchuck population. It is evident, that a woodchuck in a community where these animals are not overly abundant, will make several series of holes and utilize each set, possibly on alternate days, as its mood dictates.

During the same day several animals were seen at least one hundred yards from their dens. On May 6, 1932, twelve animals were collected. These were ranging, for the most part, from fifty to one hundred yards from the den. It was just before a rain.

Woodchucks will make considerable journeys for suitable feeding grounds, as recorded by Robinson, under the discussion of swimming. During August of 1932 I frequently visited a large field of three acres covered thickly with red clover and plantain. Almost any evening from six to ten animals could be seen in this field. From a convenient knoll, used as a vantage point, the animals could be seen hurrying from an old orchard, where they lived, to feed on the green plants of the larger field. Well worn trails through the orchard into the stand of clover were over two hundred yards in length but usually somewhat shorter in distance.

Dr. George M. Sutton, in company with some friends, saw an interesting spectacle regarding the endeavors of a woodchuck that had wandered far from home in search of better pastures. On April 19, 1931, this observer, while studying birds at Taughannock Falls, near Ithaca, N. Y., saw a "chuck" on a narrow ledge, precariously making its way along. A sheer drop of one hundred feet or more separated the ledge from the bottom of the gorge at this point. Finally it reached a talus slope, down which it plunged, and made its way to some blossoms of the coltsfoot, *Tussilago Farfara*, upon which it immediately commenced to feed. It would take a blossom in its mouth, eat it, then sit upon its haunches and look about for some time, when it would commence feeding again. It consumed many blossoms, and was observed for a long period, until the watchers finally tired and departed. Whether the "chuck" located these flowers by accident or design it is difficult to say. At any rate, the observation shows an indomitable will and a fearlessness not to be denied, nor matched, when hunger assails this creature. No hole was seen, but suitable cover for burrows was within a hundred yards.

From the above rather random observations, we may safely conclude, without gainsay, that "chucks" commonly travel a hundred yards from the den and may go an eighth of a mile when suitable food plants are not readily available.

SANITATION

The groundhog is a cleanly animal and meticulous about its toilet. The feces are deposited in a dry cell a few inches off from the main shaft of the burrow or in a terminal pocket of one of the long galleries.

More often they are buried in the mound at the entrance. I have frequently seen the animals dig a little hole, deposit the feces, and then carefully cover the hole, usually with the fore paws, but never with the nose. But Godman (1826) says:

> "There is no animal so perfectly cleanly in its habits as this marmot. However numerous they may be in any vicinity, their excrement is not seen, nor any offensive odor perceived. Whenever the calls of nature are felt, this animal seeks a spot at some distance from his dwelling, and having dug a hole of two or three inches in depth, and performed his evacuations, he covers it up with extreme care; and not content with placing a thick layer of earth over it, he presses or rather rams it down with the end of his nose, striking it with a force which seems extraordinary when thus applied."

It has been my experience, through many long hours of watching, that the woodchuck never defecates away from the den or entrance to it. All the droppings are finally buried in the mound. Frequently one finds five or six little spaces, freshly dug and worked over, which, upon being uncovered, reveal several recent depositions of feces. At times these holes are left uncovered for some time.

The young "chucks," when in the nest, deposit their feces in the nest chamber. The female covers this waste matter by continued applications of new bedding, directly over that of the old. When enough has been accumulated to make the nest unsanitary, or too bulky, the entire lot is removed, and fresh material added. Such is the case with captive animals, when furnished at all times with an abundance of food, water and plenty of nest material.

In the wild state, when the young are two or three weeks old, and some time prior to their appearance above ground, the old animal frequently cleans house; that is, she throws out damp grass matted and soaked with fecal waste. How often this is done I could not determine.

REPRODUCTION

GESTATION PERIOD

Unfortunately the writer's animals have been for the most part specimens caught wild which would not mate readily in captivity. Attempts to induce the mating act in such wild specimens were without avail. However, a female collected with a male on March 22, 1931, gave birth to five young on April 7. Thus she carried them seventeen days while confined. A large female taken on March 28, 1932, had five young on April 15. This would make the period at least seventeen days.

In all likelihood the gestation period is not over a month's time. It is certain that the animals mate in the field. This has been substantiated by field observation.

A female trapped on April 17, 1931, was so injured that she was killed. This animal contained five 60 mm. embryos all in the left horn of the uterus. I had this animal, a very dark individual, under observation for some time previously. On March 22, twenty-six days before, this same animal was noted with a much lighter colored animal, ostensibly a male, which was seen to make overtures to her. I think the mating act may have been consummated at this time. Inasmuch as the young were within a day or two of birth, this would fix the gestation period tentatively at four weeks.

Mr. William Mosher, of Perry City, N. Y., who has bred these animals and raised a number of litters, informs me the period is just four weeks.

If we turn to the evidence of analogy, we find the ground squirrels of the west have a period averaging about twenty-eight days. Shaw (1925) has found the period to be twenty-four days in the Columbian ground squirrel (*C. columbianus*), while in the thirteen-striped ground squirrel (*C. tridecemlineatus*) a much smaller form, Wade (1927) found the period to be twenty-seven days. Edge (1931) thinks the period for *Otospermophilus douglassi* to be from twenty-five to thirty days. Writing on the White-tailed prairie dog (*Cynomys leucurus*), Stockard (1929) places the period between twenty-seven and thirty-three days. The woodchuck is not far removed from these animals, and we might logically expect, because of the spring habits these animals have in common, that the gestation period of the eastern *Marmota* might approximate that of its western relatives.

FEMALE DURING PREGNANCY

The substantial layer of fat acquired during the previous fall aids the female in great measure the following spring. Her advent is frequently marked by heavy snows, frozen ground and the necessity of using bark for food. This reserve food, stored as fat, is indispensable at this period, for, paradoxically enough, woodchucks commonly retire for the winter sleep in a land of plenty, and emerge from this long slumber weeks before the first green plants are in evidence. Little is eaten for the simple reason that there is nothing to eat.

At this time the bark of wild cherry, sumach, apple, occasionally hickory and perhaps some other barks are consumed, but at best it is a long fast. "Chucks" probably eat little for a few days preceding parturition, if the habits of captive individuals are any criteria of wild animals. Caged animals have a tendency to become restless a day or two before the young are born, and frequently take food into the nest or tunnel. Probably this habit is not restricted to captive individuals, for on April 19, 1932, when a large burrow was excavated, small pieces of green sod, grasses, and clover, showing evidence of having been fed upon recently, were encountered well within the burrow. The female trapped from this burrow had well advanced embryos, within a day or two of birth.

NUMBER OF YOUNG

The average number of young is 4.07. This figure is derived from embryo counts in thirty-one gravid females, in addition to counts of the uterine placental scars of eighteen woodchucks recently past parturition. Field observations on families of young, bear out the number arrived at by foetal counts, and show that prenatal counting does not give a higher percentage than is to be expected. The average number of a score of families under observation during the spring of 1923, 1927, 1931, and 1932, is slightly greater than four (4.3).

Not infrequently foetal atrophy reduces the original number of embryos. Four instances were encountered in making foetal counts. Occasionally one finds an embryo less developed in size than the normal ones. These may, in some instances, be born dead. Probably many live a number of weeks, but, handicapped as they are, in all likelihood, they eventually succumb. In the spring of 1932 I had a captive female give birth to five young. Of these one was noticeably smaller than the others, and differed remarkably in coloration. In general, its coat color was a uniform ochraceous-orange. This individual lived for thirty-two days, but became constantly weaker after it had reached the third week.

Several times, when an entire family in the field has been collected, one young was found to be considerably smaller than the others, and proportionately less developed.

That they do not all have the same physical endowments at birth, is shown by a litter of three young born on April 28, 1932. One weighed thirty-nine grams, another thirty-three grams, while the runt weighed twenty-four grams. Obviously this young one, even though of a small litter, would be greatly handicapped.

TIME OF BIRTH

The earliest actual date of birth I have recorded is the case in which a captive female bore young on April 7, seventeen days after she was captured. These were perfectly normal, and well developed in every way. Another, collected on the same date, had 60 mm. embryos. Obviously, these were within a day or two of birth, for embryos 60-68 mm. were practically as well developed and as large as new born young.

On April 11, 1931, a female was collected with five 62 mm. embryos. These likewise were ready for birth. On April 18, two nursing "chucks' were shot.

As late as May 1, 1931, an animal with two 18 mm. embryos was shot. These were assumed to be about four-fifths developed, and would have been born within the week.

Thus the young are born in central New York from the first week of April until the middle of May, over a period of five or even six weeks.* Probably some young are born in late March, for our record of thirty-one sets of embryos is in no ways a complete study. From these observations, however, one might reasonably infer that six weeks would cover the period over which the young are brought forth. We should hardly expect to find such a prolonged period for the presentation of the young if the animals had mated the previous fall. Bats, some mustelids, and bears, usually have young, in their respective groups, within a few days of one another. Especially is this true of bats, in a large colony, when the young are born over a period of a very few days. It is common knowledge that these groups mate the year preceding the birth of the young, nearly twelve months elapsing in the case of the fisher.

Possibly woodchucks have several œstrual cycles in the spring, at which times the males serve the females, if available. It is of interest

*Mr. Owen Beckwith of McLean, N. Y., collected a large gravid woodchuck on May 26, 1933. Beckwith stated that the animal contained four large embryos, about the size "of my thumb." These were, in all probability, within a day or two of birth, and constitutes the latest record of a pregnant female I have encountered.

to note that the larger, older animals mate the earliest, consequently the young first seen with the parent are those conceived during late February or early March. Some very small females were carrying young in early May.

The following table, showing the records of embryos taken from gravid females during the spring of 1931 and 1932, is designed to show the relative development of the embryos throughout the spring. In a few instances, where placental scars are visible, are included records that indicate the number of young. All measurements from the crown to rump are expressed in millimeters, and were made with dividers.

Development of Embryos

Date	Number	Position	Size
March 31, 1932	4	3 left, 1 right	3 mm.
April 1, 1931	4	2 left, 2 right	23 mm.
April 5, 1931	6	6 right	11 mm.
April 7, 1932	4	2 left, 2 right	60 mm.
April 7, 1932	5	......	Young born in captivity
April 11, 1931	5	5 left	61 mm.
April 11, 1931	5	1 left, 4 right	35 mm.
April 14, 1932	3	2 left, 1 right	32 mm.
April 12, 1931	6	1 left, 5 right	13 mm.
April 15, 1931	5	......	Young born in captivity
April 16, 1931	4	2 left, 2 right	40 mm.
April 17, 1931	5	5 left	55 mm.
April 17, 1931	3	2 left, 1 right	62 mm.
April 17, 1931	5	2 left, 3 right	26 mm.
April 17, 1931	2	1 left, 1 right	18 mm.
April 17, 1931	4	2 left, 2 right	15 mm.
April 17, 1932	3	3 right	35 mm.
April 18, 1931	4	3 left, 1 right	Just born
April 18, 1931	4	1 left, 3 right	33 mm.
April 18, 1931	5	2 left, 3 right	Recent parturition
April 21, 1932	5	2 left, 3 right	34 mm.
April 21, 1932	3	2 left, 1 right	14 mm.
April 21, 1932	4	......	Young born in captivity
April 21, 1932	4	......	Young born in captivity
April 23, 1932	4	4 right	Recent parturition
April 24, 1931	4	3 left, 1 right	Recent parturition
April 30, 1932	4	2 left, 2 right	24 mm.
May 1, 1932	2	1 left, 1 right	18 mm.
May 2, 1932	5	4 left, 1 right	Recent parturition
May 4, 1932	2	1 left, 1 right	68 mm.

DESCRIPTION OF YOUNG

The following notes are based on observations made on seven litters of new born young, comprising thirty-one individuals. Three of these litters were successfully raised by the parent until they were weaned.

YOUNG AT BIRTH

The young, as with various species of ground squirrels at birth, are blind, naked and quite helpless. In general, directly after birth, the color is dark pink; it is flesh color twelve hours after birth. The only hairs are five small ones directly over the eye, measuring 2 mm. in length, together with five somewhat shorter genal hairs on each cheek. The external auditory meatus is closed, while the eyes appear merely as a darkened area on the face. The fore limbs are, of course, much better developed than the hind limbs. The young animals are quite active but their movements are not coordinated. One individual remained active, when removed from the parent, for thirty-two hours, when it was killed. At birth a sucking note is readily heard from a distance of several feet. (Plate XV, fig. 1)

The average measurements of eight new-born young, four males and four females, are as follows: total length, 105 mm., tail, 16 mm., hind foot, 13 mm.

There is no apparent correlation between the weight of the litter and the number of young comprising it. The following table bears this out.

WEIGHT OF YOUNG AT BIRTH

NUMBER OF YOUNG IN LITTER	WEIGHT OF LITTER IN GRAMS	WEIGHT OF INDIVIDUAL
5	140	28, 28, 26, 25, 35
3	96	39, 33, 24
3	78.5	28.5, 26, 24
5	124	29, 25, 25, 23, 22
4	113	33, 28, 28, 24

The average weights of twenty individuals from birth to twelve hours after birth averaged 26.5 grams.

ONE WEEK OLD

The head and back is heavily pigmented. The snout and forehead have short grayish fur, darker on the forehead, while the rest of the body is without visible hair. The genal vibrissæ are especially prominent, while the mouth is very large. The fore claws are black at their base. The fore limbs are still noticeably stronger and larger than the hind ones. The remnant of the umbilical cord has completely disappeared but the scar remains. In general, the dorsum is sooty gray, but the belly remains flesh-colored. (Plate XV, fig. 2)

The average measurements of eleven are: total length, 120 mm.; tail, 22 mm.; hind foot, 16 mm. The average weight of nine individuals was 52 grams.

TWO WEEKS OLD

The fur of the snout has become grizzled gray, almost approaching white, being the longest hair on the body except that of the vibrissæ. The chin and upper throat are colored like the snout. Head with short black fur, back of neck and fore part of dorsum above shoulders a light brown, the rest of the body with short dark brown fur, almost approaching black in places. The fore claws are jet black. The hair of the outer side of the fore limbs, in the region of the elbow, are now the longest on the body. The genal vibrissæ are quite long, as are those of the upper lips, while the gular vibrissæ have made their appearance. These latter sensory whiskers measure 6-8 mm. in length.

The average measurements for seven are: total length, 150 mm.; tail, 35 mm.; hind foot, 26 mm. (Plate XV, fig. 3)

Nine specimens have an average weight of 80.5 grams.

THREE WEEKS OLD

The head is black, excepting the snout, which is still with a grayish cast. This is being rapidly effaced by the appearance of black hairs about the nose. The lower fore limbs remain black, as do the nails, while the upper arm has taken on a decidedly reddish brown luster. The tail is better furred at the distal than at the proximal portion, as is the condition in adults. A pronounced sucking note is evident most of the time at this age, except when the animals are sleeping. The young can crawl about readily, but are incapable of supporting the body above the substratum. (Plate XVI, fig. 1)

The average measurements of seven are: total length, 191 mm.; tail, 36 mm.; hind foot, 32 mm. The average weight of these individuals was 130 grams.

FOUR WEEKS OLD

Eyes are opened. One young opened an eye at twenty-six days, another opened a single eye on the twenty-seventh day, while all had both eyes opened on the twenty-eighth day. An apparent effort on the part of the animals to open their eyes, a day or two before this event actually took place, was noted. Much twitching of the lids preceded the actual opening. When first opened, the eyes appear to have a thin blue film over them. This disappears within from twelve to twenty-four hours and the bright handsome eye is present. With the opening of the eyes, the entire life of the animal undergoes a change. The young commence to feed upon green matter, and venture hesitantly from the nest box or tunnel. (Plate XVI, fig. 2)

At this stage, the top of the head, between the eyes, the fore and hind legs, are black, while the rest of the body is a grizzled grayish brown, with an indistinct gray saddle. The sparsely furred belly has a rusty cast. An individual preserved at this age had both milk and green matter in the digestive tract. The tongue is enormous in young woodchucks. A specimen, four weeks old, had a tongue twenty-six millimeters in width. This necessitated curling on the sides to fit in the smaller mouth cavity.

The young probably leave the den for the first time with the opening of the eyes. The lower incisors have erupted, and the milk teeth between them appear ready to be lost. The upper incisors have not broken through the gums, although they appear as small white knobs.

The average weight of seven animals was 188 grams.

FIVE WEEKS OLD

The young now have the typical coloring of the unshed adults. The small animals are not fuzzy, but are sleek little fellows. The upper incisors are just erupting. The babies are now able to emulate the adults in voice, for when handled they grate together the cheek teeth, making that noise so common to adults. The whistle of alarm is frequently heard from these precocious individuals. Several of the young are still attempting to nurse. (Plate XVI, fig. 3)

The average measurements of seven are: total length, 260 mm.; tail, 55 mm.; hind foot, 47 mm. The average weight of these is 247 grams.

From this period on, all young "chucks" have emerged from the burrow, and are romping and playing about while not engaged in feeding. Their growth is rapidly accelerated with the weaning period past, and a varied diet of succulent young plants to tempt them. Captive young, at seven and one half weeks, weigh a pound, while wild individuals, estimated to be not more than eight weeks, are a pound and a quarter. At seven weeks captive individuals average, in measurements, as follows: total length, 292 mm.; tail, 63 mm.; hind foot, 54 mm.

As the care of the young at this age took more time than I had at my disposal, all were liberated when eight weeks old after being marked to identify them readily if recaptured.

THE NURSING PERIOD

Directly after giving birth, the female normally eats but little. A captive that had five young during April, 1931, did not feed for three days following parturition, although a generous supply of greens was supplied daily. A "chuck" that had young on April 7, 1932, fasted until the afternoon of the 10th. A captive that had young on April 21, 1932, commenced to feed about twenty-four hours after delivery. It might be inferred from these brief observations that females with young born early in the season do not require food for some time after the young are brought forth, as their storehouse of fat allows for sustenance both for them and their young. It is obvious that there is a paucity of food during these early days of spring. With the coming of dandelions, grasses, and the earliest clover, food is more readily obtained, and the reservoir of fat has quite disappeared.

As the young develop and approach the fourth week, the mother customarily takes food into the tunnel or nest chamber in anticipation of the weaning period, now close at hand.

The eight teats—two pairs, thoracic; one pair, post-abdominal; and one pair, inguinal—are equally used. All are swollen and produce a good flow of milk. The first to become dry is the anterior thoracic pair. (Plate XX, fig. 3)

In the act of nursing, it seems not unlikely that the female will stand upon her four feet rather than lay on her side, as do rats, mice, and most small quadrupeds. Repeated observations of suckling young have illustrated this thought. It may be that the intrusion of an observer has driven the nursing animal to this position, but great care has been exercised in observing the nest life of the animals, so that a minimum of noise has been made to disturb their otherwise normal actions.

When the young first leave the nest, they are still nursing. Frequently they will grasp a thoracic teat and commence to feed when the female is in an upright position. Occasionally they will be rebuffed by a sharp blow of the fore paw, especially if they become overzealous in their endeavors and hurt the mother. Apparently she suffers some discomfort when the young are nursing in this manner for she appears uneasy and ill at ease after a few moments of such treatment. The nipple may be long drawn out after the endeavors of the young. They also feed from the abdominal and inguinal teats when the female is in a standing posture, but this is not as frequently observed as the other. Writing of *Marmota caligata*, Harmon (1822) says, "they generally produce 2 young at a time, and set upon the hind feet when they give them suck."

It sometimes happens that the venturesome young ones, straying from their nest when they have first appeared, become exhausted from their efforts, and lay motionless. The mother then carries them back to the nest, lifting them either by the loose skin of the back of the neck or over the shoulders.

DEVELOPMENT OF YOUNG THROUGH THE FIRST SUMMER AND FALL

In the spring of 1931, the first young woodchucks were seen outside the den on May 19. These were feeding within a few feet of the entrance, while the mother travelled about one hundred and fifty feet from them in search of food. On May 22, 1931, a young male was collected. It had the following measurements: total length, $14\frac{1}{8}$; tail, $3\frac{1}{2}$; hind foot, $2\frac{5}{8}$. It weighed 1 lb., 6 oz., and was estimated as eight weeks old, on the basis of weights and measurements of captive individuals. This animal must have been born late in March.

From May 19 to 29, 1931 and 1932, twelve young "chucks" were secured. These average 1 lb., 3 oz., and the average measurements are: total length, $14\frac{1}{2}$; tail, $3\frac{1}{2}$; hind foot, $2\frac{1}{2}$.

During June of 1923, 1931, and 1932, nineteen young were collected. These average 2 lbs., 1 oz., and the measurements for these average: total length, 16⅛; tail, 4⅜; hind foot, 2⅝.

Young shot in July of 1931 and 1932 number twenty. These average 3 lbs., 4 oz., and average: total length, 20; tail, 5; hind foot, 3.

August young, over a two year period, total twenty-six individuals. These average just 4 lbs. and the measurements are: total length, 20⅓; tail, 4¾; hind foot, 3.

Measurements of twenty-eight young collected over a two year period in September give an average weight of 5 lbs., 13 oz. (4-4, 7-8). Males are somewhat smaller than females, for the latter average 6 lbs., 4 oz., for thirteen individuals, while fifteen males average 5 lbs., 6 oz.

The measurements of these twenty-eight young average as follows: total length, 20⅘; tail, 4½; hind foot, 3. Thus we have an increase in body length of nearly an inch, in spite of the fact that tails of August specimens average somewhat longer than those of animals taken a month later.

It frequently happens, in studying specimens collected in September and October, that little or no immediate difference can be detected, externally, among large young of the year and adults. For a study of growth, it is highly desirable to fix the age of these individuals, in order to determine correctly the rate of growth and seasonal development of the young. Weights and body measurements are of some aid, but the real indices are found in the skull and in certain bones of the skeleton.

Young animals can usually be determined at a glance until the first of August, when they commence to approximate in size the subadults or small animals of the previous year. The following table is designed to bring out certain salient facts regarding the discrimination of young from old animals.

Some of the characters listed below under "less than a year old" may be found in these same individuals in the following spring. At that season, however, there is no danger of any confusion, for all are a year old, or more. The fusion of bones, loss of sutures, and ossifications of the epiphysis, are all accomplished in these animals before the young of the year have grown sufficiently to warrant any critical analysis, in order to separate the two groups.

CRITERIA FOR DETERMINING AGE GROUPS OF WOODCHUCKS

LESS THAN 1 YEAR OLD.	MORE THAN 1 YEAR OLD
Median occipital keel wanting, or if present very weak.	Median occipital keel usually strong.
Distinct suture separating frontal and parietal elements dorsally.	Frontal and parietal elements fused dorsally.
Occipito-nasal length under 84 mm.	Occipito-nasal length usually over 86 mm.
Pm. 1 and 2 in upper jaw and pm. 1 in lower jaw of milk dentition present.	Permanent dentition present.
Well marked sutures separating three principal elements of innominate bone.	Elements of innominate bone fused. No sutures visible.
Epiphyses of radius, ulna and humerus incompletely ossified. Ulna not exceeding 65 mm.	Epiphyses of radius, ulna and humerus strongly ossified. Ulna exceeding 70 mm.

As has previously been stated, this table has its greatest usefulness in determining large young collected in September, and small adults taken during the same time. External measurements are apt to give faulty interpretations as to the correct age of the animal under consideration.

October young are represented by four individuals. These average just an even 6 lbs. A $3\frac{3}{4}$ lb. individual, taken on October 3, 1931, has not been included. This was a poor animal, had not molted and was otherwise in a sorry condition. The measurements of these four average: total length, 21 $\frac{1}{2}$; tail, $5\frac{1}{2}$; hind foot, $3\frac{1}{8}$.

RELATION OF THE FATHER TO THE FAMILY

Seton (1909) has said that some woodchuck fathers actually seem to stay, or to return home, and that they divide with the mother the care of the young.

I am inclined to agree in this statement, most certainly so in some instances.

A captive female, caged with a male in the spring of 1932, gave birth to five young. At the time of parturition the male was present in the nest chamber and remained with her until about twelve hours later, when he was removed. The young were successfully reared. At no time during pregnancy did I see the female assume a belligerent attitude toward her consort. He appeared to be accepted as a matter of course. It is obvious that such an observation has little value toward an understanding of the conjugal felicity of these rodents, captive as they were. But the following records from the field offer substantial evidence that the male remains with the family, or is normally very close.

On May 26, 1931, a female with three young was observed feeding. The female and one young were collected. An hour later an adult "chuck" was seen at the entrance to this hole wagging its tail from side to side. It is assumed that this was a male.

During the late afternoon of June 6, 1932, two old "chucks" and four young were seen feeding together. They all scrambled into the same hole when alarmed.

On the same date, a large individual was shot at, but escaped unscathed. In its haste to get off, it ran into the nearest hole at hand, a burrow occupied by a large female and her young. It soon scurried out and made off to another system of burrows, some one hundred and fifty feet away. Possibly this indicates that all woodchucks do not tolerate the presence of their kind during the period when they have young. Further studies on this factor in the animal's life are desirable.

RIVALRY AMONG MALES

Woodchucks commonly fight among themselves during the early spring. That these vernal combats are usual among the males alone, perhaps over a prospective mate or a bit of choice territory, is not so readily determined.

From my notes of April 7, 1923, the following is extracted. "While fishing today along a small stream west of Trumansburg, N. Y., I approached quite close to two "chucks" engaged in noisy combat. The larger had a grip on the other's ear, while this unfortunate smaller individual squealed unlike any "chuck" I have ever heard. In attempting to approach closer, the better to witness the fray, I was seen, and the smaller quickly tore itself loose and "denned" in a nearby hole. The larger appeared quite unconcerned over my presence, and remained in the field for some time."

On April 15, 1931, several males were collected that showed unmistakable signs of recent vicious encounters. One was minus an ear, the wound quite fresh, while several had deep gashes on the head and forelegs. A few taken throughout April have had large, freshly healed scars on the forehead.

A subadult male shot on May 21, 1931, had a large scar on the chest and right foreleg. These wounds were healed over but contained a quantity of pus. A large male lived within seventy-five yards of this individual and a litter of young were secured within one hundred yards of the wounded animal's quarters.

The females do not always escape from battle. A lactating female collected on May 1, 1931, had a prominent, raised scar on the forehead, between the eyes. Of course it is possible this may have been the result of a bullet the previous year. A smaller, freshly healed "bite" was certainly an episode of but a few weeks previous.

On May 27, 1931, a female was easily overtaken in the field. When it attempted to run it fell on its side repeatedly. Examination revealed a large scar on the shoulder, the size of one's thumb. A large festering sore, as large as a golf ball, on the animal's felt flank, may have been due to a bullet, but quite possibly the result of a fight.

On April 6, 1932, a small male was taken which had a severe gash on the right foreleg and an ear missing. Three "chucks" in all have been collected at one time or another that have had an ear missing. One individual had lost both. Frequently the distal part of the tail is absent, and a bob-tailed male was collected in the spring of 1923 near McLean, N. Y.

AGE OF SEXUAL MATURITY

While woodchucks do not commonly complete their growth until late in the second year, they frequently breed as subadult, when one year old. Positive proof of this is furnished by marked individuals.

During the early summer of 1931 a number of young animals were trapped, and when not too badly injured, were marked and liberated. Marking was accomplished by punching or clipping an ear and excising a toe. Of eleven individuals so marked, only two, both females, were recovered the following spring. One, taken March 29, 1932, weighed three pounds, six ounces, but contained four embryos. Another marked individual, taken a week later by Mr. Edward Drake, carried no young but might have bred later in the season, had it been allowed to live.

Not only do the subadults have fewer young, but they frequently go unmated the first year. In 1931, I collected thirty-nine females during the breeding season, assuming this to be from mid-March to mid-May. Of this number, twenty-one were subadults, or commencing their second year. Fifteen had not bred while six were carrying young. Of eighteen adult females, seventeen had mated while only one had failed to breed.

In 1932, over the same period, a late spring and much snow kept woodchucks under cover so that fewer were secured early in April. But of twenty-six adult females, all had bred, while seventeen of twenty-two young females had not conceived.

Thus we find, over two breeding seasons, only one of forty-four adults had failed to breed, while of forty-three subadults taken during this period, all but eleven were virgins.

We cannot attribute this larger number of unbred females to lack of males, for they are as numerous as the females. In tabulating the sex of all the woodchucks taken, we find the males to outnumber the females in the ratio 114-100. This count, or ratio, may be fortuitous, but further studies will probably prove it to be rather accurate. The males of white rats outnumber females. It is likewise so of man.

Of eighty-three males taken from March 15 to May 15, 1931 and 1932, forty-five proved to be subadults. Of these, fifteen had enlarged testes, but only four individuals had them descended into the scrotum. These were animals collected early in May. Perhaps the young males do their share of the breeding as the season advances. Only four of the thirty-eight adult males did not have enlarged testes. The remainder had gonads that were swollen and descended.

It is difficult to determine to what size the testes must enlarge before they are functional. An arbitrary length of twenty millimeters was decided upon to separate supposedly breeding animals from those not breeding. Descended testes always measured more than this; smaller subadults never have testes as large.

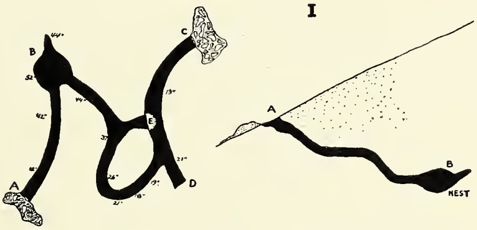
Measurements, in millimeters, of descended testes in fully adult males, give random figures as follows: 24 by 15, 26 by 14, 27 by 13, 30 by 17, 20 by 12 and 30 by 18. The average weight of six pairs of descended testes was 7.6 grams. Among subadults, similar measurements are: 15 by 6, 16 by 9, 14 by 5, and 15 by 9.

All through the summer specimens are occasionally collected which have enlarged testes. These gonads never assume the proportions of those in individuals collected in the spring.

BURROW AND NEST

Woodchucks are primarily fossorial animals when at home. These big rodents are confirmed diggers, being well equipped for such toil by virtue of their strong fore limbs, with stout black claws, and a capable set of strong white incisors, to tear away roots that might impede the progress of their route though the soil. The teeth are frequently brought into play when the woodchuck commences a burrow at the base of a large tree, and so maps its route that it will lead between two large roots. These give the home better protection from that other good digger and arch enemy, the red fox.

The burrows of this creature are found in woods, meadows, hillsides and any transitory area between these. They may be recognized as the work of woodchucks, as contrasted with that of skunks, rabbits, foxes, etc., by the ever present pile of fresh dirt that is constantly added to the mound. This mound, which is an accumulation of dirt that has been transported from the innermost recesses of the burrow,



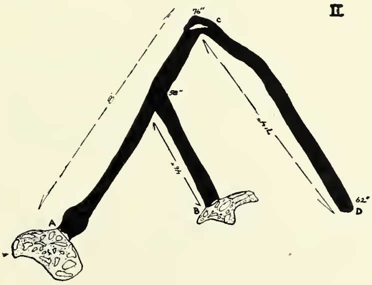
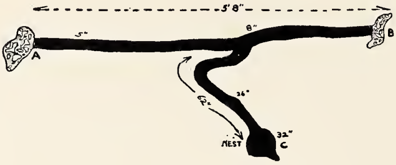


FIG. I. A large burrow situated on a side hill. Pocket at E had about a quart of accumulated feces. A large nest of grasses uncovered at B.

FIG. II. A long established den situated on a decided slope. A large accumulation of feces at D.

III



IV

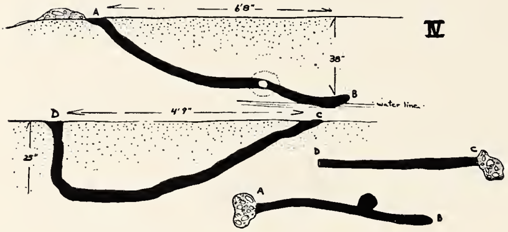


Fig. III. Hibernating den of Woodchuck.

Fig. IV. Adjoining Woodchuck burrows. The two figures to the left are side views, the figures to the right show their relative position to one another. The pocket in the tunnel A-B had a large accumulation of feces.

seldom passes a week without fresh material being added. Good criteria of the woodchuck's presence are foraging trails, leading from one burrow to another, and striking at every angle from the main shaft into the surrounding fields.

There are usually two entrances, sometimes three, rarely four or even five.

The shaft from the main hole (that with the most prominent mound) slopes at varying angles. Young animals of the year, when first commencing the strenuous task of making homes for themselves, commonly have only one entrance, and this is usually of a shallow nature. Older animals strike deeper, and the tunnel may pass at an abrupt angle for almost a foot, before the incline grades off.

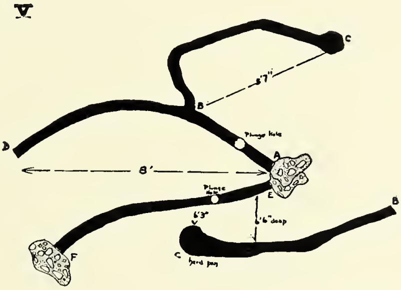
In general, woodchucks have wide entrance holes that narrow very abruptly a few inches after leaving the surface. Holes that may have a diameter of twelve inches at the entrance have a bore of only four inches when a foot of earth has been excavated.

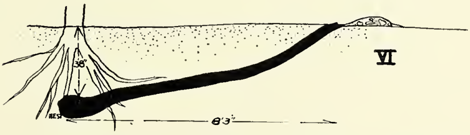
Usually the woodchuck makes some provision for a spring freshet or high water by having the lowest part of the shaft midway between the entrance and the nest chamber. When the nest is at the lowest part, as sometimes happens, immediately behind it and away from the entrance, a short blind pocket may be found, leading up and away from the nest. That the animals do not always plan wisely or choose well, in selecting a site for a burrow, is evident from the following observation. On April 12, 1931, in company with Mr. Robert Rightmyer, the writer saw a woodchuck disappear into a hole on the summit of a rather extensive ridge, composed for the most part of heavy clay soil. We looked in the hole and could see the animal, immersed in water to its neck. The site was not an appropriate place for a burrow, as standing water had all but flooded the occupant out. On seeing us, the animal pulled under the water, but could not remain in such a situation long, and was easily dispatched.

There appears to be no consistency as to the width or height of the burrow throughout its course. Part of the burrow has a diameter just sufficient for the animal to squeeze through. In stony soil, protruding stones sometimes block the passage so as to make any real speed difficult in the underground runway. Again, the tunnel may widen to permit of easy turning for the animal.

At the entrance there is usually a somewhat widened area. This is

V





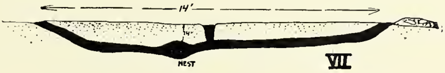


FIG. V. A large Woodchuck burrow. B-C is represented in side view in lower part of drawing.

FIG. VI. Hibernating den of Woodchuck.

FIG. VII. Hibernating den of Woodchuck. A large female was taken from the nest.

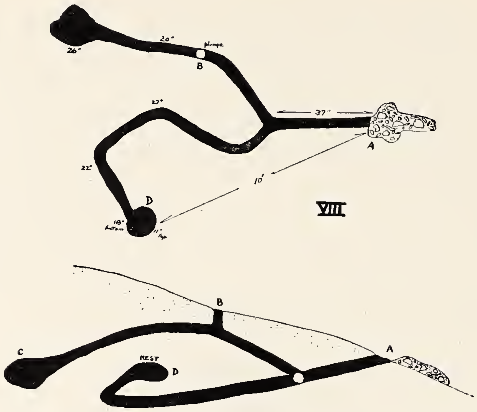


FIG. VIII. A long established Woodchuck burrow. Upper figure is view from above, the lower a side view. A Woodchuck hibernated in the nest at D.

resorted to when the animal runs in the hole and immediately appears again at the entrance, turned about. Again, in many instances, but more especially in burrows long established and occupied by old animals, there is a simple platform (Plate XVIII, fig. 3), an inch or so below the general surface. The woodchuck will rest the forepart of its body on this area, while surveying its domain. The diameter of the entrance hole in one hundred burrows, measured three inches from its inception, averages 6.7 inches in height and seven inches in width. In seventy instances it was slightly less than this, the remainder being larger. In general, the size of the inhabitant can be roughly judged from the size of the hole. The largest hole measured was twelve by fourteen inches and housed an 11¾ pound "chuck." Holes in hedgerows are larger than those in the open field, perhaps because they have been longer established and because they have protected a greater number of animals, including skunks and rabbits.

The plunge hole has a diameter which is considerably smaller than that of the other holes. It is never larger than is necessary to admit the animal's entrance. They frequently measure four by four or four by five inches.

The size of the hole is directly dependent on the type of soil the woodchuck has chosen for the burrow. The depth of the burrow is likewise fixed by the texture of the soil. In sandy situations, woodchucks will dig to a depth of six feet, while in gravelly soil, composed of many large stones, the depth is rarely greater than four feet, and frequently not that.

The angles of entrance are less marked on level ground than in burrows situated on a pronounced slope. The angles on a slope strike deeper, and are considerably more abrupt.

The speed at which excavating is done is amazing. A woodchuck can bury itself from view in a minute, providing the soil is reasonably light and porous. Simple burrows with a single entrance, totaling five feet in length, are completed in a day. Three such instances, recorded in August, 1932, show burrows probably made by young animals doing their first digging, to average five feet in length, but of rather a shallow nature. These were all made in a single day. It is even possible that they were the work of one animal, as they were all within a hundred yards of one another. It seems more likely that a family, recently broken up, had been jointly responsible for the fresh burrows.

The deepest burrow I have unearthed in central New York went to a depth of seventy-six inches, or well over a tall man's head. Others that have been opened have penetrated to a depth of five feet rather frequently, but usually the nest chamber is located within two feet of the surface, and not infrequently little more than a foot.

From the main shaft one encounters blind pockets. In these may be found fecal remains, partially covered by dirt. At other times they form a hard dry cell, perhaps a foot from the principal tunnel. It is not unlikely that these have served as hibernating cells. All the burrows opened in seasons other than winter have had these chambers. Winter excavations have failed to produce such cells. It is not beyond reason to suspect their presence, but being plugged tightly, they could not be detected. Inside these were possibly dormant animals, safely ensconced for the long sleep of winter.

NESTS

The nests are usually rather small for such a large animal. They seldom measure more than fifteen inches in diameter and half as high. They are constructed from the nearest available material. In woods, the fallen leaves of deciduous trees are used, while in fields studded with goldenrod and asters, the dead leaves of these plants are utilized. A combination of dead leaves and dry grasses often makes up the sleeping quarters, but more frequently the nest is constructed wholly of grass. About one third of the excavations revealed no nests, simply an enlarged chamber at the furthermost recess, yet such burrows were known to be tenanted. (Plate XIX, fig. 3)

TRAILS

Leading from all occupied burrows are well defined trails. These are especially prominent in late spring and summer, and again after the hay is cut. When the grass is high it conceals these trails, arching over them, so that frequently, when the runway passes through exceptionally tall herbage, a tunnel-like passage results.

These trails are narrow, seldom more than two or three inches in width, and connect up each system of burrows with the next. In a field of an acre in extent, there may be five or six woodchuck burrows. These will connect with one another by well worn paths. Solitary animals, especially old males, will have as many as three sets of burrows over their feeding ground, and wander widely in searching for food.

The approach to the nest is usually made through these trails. Under cover of rank vegetation, or even in fields with low growing plants, the animals keep to these narrow files when leaving or approaching their burrow. When the hay is cut, and the meadows and fields again leave woodchucks exposed, they still resort to these well worn runways. An animal may be feeding fifty yards from the den, and surprised, make for its home. In spite of a short cut that would save it several seconds in reaching the sanctuary of its underground retreat, it will yet confine its route to the lane it has used so long. This has been the undoing of many woodchucks, as a good marksman can frequently have time to place a fatal bullet before the animal has "denned."

In gathering nesting material, the woodchuck may go a long or a short distance from the nest, depending directly on the accessibility of available material.

On April 4, 1931, a large "chuck" was observed gathering grass for its nest. This animal tore at the already loosened grass with its forepaws, then bit it off, or pulled it up with the teeth. It never ventured more than twenty yards from the hole, and spent about from thirty to sixty seconds securing material on each trip. It was observed from 4 until 5 P.M., in which time it made twenty-one trips, each time carrying the equivalent of a small fistful. When I left it was still engaged in carrying in bedding material. This animal had young out of the den on May 19, when they were estimated to be six weeks of age. Thus she was making a nest, or repairing one, about a week or ten days before the young were born.

Another individual was seen carrying large mouthfuls of dead oak leaves to its den on August 15, 1929. It made about twelve trips per hour, and travelled seventy yards for its nest material.

In collecting grasses for the nest, the woodchuck will frequently manipulate the loose dry grass with its paws, while holding it in its mouth. The loose ends are tucked in and folded, so that no stray piece will be lost on its journey to the den.

OTHER OCCUPANTS OF WOODCHUCK BURROWS

The woodchuck plays host to a veritable army of mammalian intruders, all seeking a sanctuary against the elements, protection from their enemies, or a place in which to rear their young.

Rabbits

Cottontails utilize the burrows of woodchucks frequently. During the fall they spend most of their time in a "form" above ground, but with the advent of snow and severe weather the cottontails repair to a woodchuck burrow. They likewise make use of these holes during the spring months, and possibly bring forth their young upon occasion in these underground retreats. They, however, generally have the young in a slight depression of their own making.

Skunk

The skunk is an adept digger, but seemingly prefers to usurp a "chuck" burrow when such is available. They may at times be found in the same hole with a woodchuck. Skunks will frequently alter these burrows, more especially the nest chamber, enlarging it to accommodate four or five individuals, as is their habit during the winter season.

Fox

Red foxes probably frequently make use of the dens made by woodchucks they have conquered. At least one instance of this was furnished near McLean, N. Y., on May 3, 1925. A lactating red fox was collected at the entrance to a woodchuck burrow. When the burrow was excavated, four young foxes, about five weeks old, were secured.

This was in an open field, in good woodchuck territory, and had all the earmarks of a remodeled woodchuck home.

WEASEL

Weasels venture into the burrows of woodchucks, at least rather frequently in the winter and spring months. Tracks in the snow often reveal such records. Definite records of spring use have been secured twice. On April 8, 1932, I saw a woodchuck at the entrance to a hole bordering a large stream. A trap placed well within the hole, with a rock completely blocking any escape, caught during the night an adult male *Mustela cicognanii.* Mr. Edward Drake took a nursing female weasel of the same species at another woodchuck hole on May 13, 1932. The hole was tenanted by a woodchuck at the time. The following day his trap held a fine male specimen of this weasel, ostensibly the mate to the animal caught the preceding night.

CHIPMUNK

On March 26, 1932, I set about twenty traps for woodchucks. There was a quantity of snow on the ground at this time. Five chipmunks, *Tamias striatus lysteri*, were caught in the morning, all rutting individuals. From their position in the trap, it would indicate that they had been in the hole, perhaps the previous night. Possibly they frequently resort to such chambers for their hibernating period, making little tunnels or pockets to the side of the chamber.

HOUSE CAT

Inside a large woodchuck hole I placed a trap on April 9, 1932. The hole had been somewhat enlarged, but without a noticeable mound at the entrance. The following morning the trap held a large house cat. The animal was a female, carrying three embryos of approximately half time development, and stomach crammed with the remains of a rabbit. Apparently the cat had made this burrow her home for some time, as old rabbit fur was strewn about. She may even have planned for the arrival of the kittens in this burrow.

It is not unlikely that mink, muskrats (near water), squirrels, and other mammals frequently resort to vacated woodchuck burrows. The writer, however, has no positive data concerning these forms.

MEASUREMENTS

The conventional measurements were taken of all animals collected. This includes the total length of the animal, the length of tail, and length of hind foot. Various methods have been adopted by field naturalists for recording these measurements. The commonly accepted way is to lay the animal on its back, manipulating the limbs to alleviate to some degree the effects of *rigor mortis*, providing this has set in. The table on which the animal is laid may be conveniently marked off. If a ruler is to be used, a steel one is preferable.

The effect of gas collecting in the intestines of dead animals has a tendency to bloat them, and shorten the body length. This, together with the effects of *rigor mortis*, gives us measurements that are not a true index to the correct size. For example, an animal measured immediately after death in the evening, or not later than two hours after it has been killed, will have an apparent greater length than the same individual measured the following morning, when stiff, or perhaps at noon of that day, when decomposition permits a ready manipulation of the animal. The measurements, but more especially the body length of the creature, will vary as much as fifteen per cent from its normal size, taken under such conditions as outlined above. The hind foot is little affected by these conditions, and for this reason is a better index of the animal's true size, and in some cases, its age. In woodchucks, the hind foot becomes fully grown early in life, and like other rodents, we find little variation among adults. When an exception to this occurs, it is not apt to be well marked.

The tail measurement is accomplished by placing a ruler on the upper side of the tail, at its base, then bending the tail at right angles to the body. The tuft of hairs at the tip is disregarded in calculating this measurement.

Throughout life the tail tip is especially subject to injury, as has been recorded in *Microtus* by Howell (1924). This is a frequent instance observed in the males, which may engage in battle with one another over a likely mate, a piece of territory, a desirable hole, etc. Numerous animals have shown beyond any doubt upon examination, that their tails have been foreshortened in one manner or another. In measuring this appendage, all injured tails have been disregarded in the final compilation of data in order to determine average measurements for a large series.

MEASUREMENTS OF ADULT WOODCHUCKS

All specimens included here have been taken in central New York, within a few miles of Ithaca. The measurements have all been recorded by the writer, who alone is responsible for them. The animals listed include subadults, (that is, in their second year), but are for the most part sexually mature, and very old individuals. In general, collectors have a tendency to preserve the largest individuals of a species. This may account for the measurements and also the weights, which appear in many reports, averaging higher than those cited below.

The average measurements for 167 males, measured in the flesh within an hour or two of death, are as follows: total length, 22.5 inches (25-19); tail, 5.15 inches (6-4.25); hind foot, 3.15 inches (3.5-2.75).

One hundred and thirty-one females average: total length, 22 inches (25.25-18); tail, 5 inches (6.1-4.2); hind foot, 3 inches (3.4-2.6).

Averages for 298 individuals of both sexes are: total length, 22.2; tail 5.12; hind foot, 3.1.

WEIGHTS

It is to be expected that weights of animals will vary considerably more than measurements. Such factors as quantity of food in the alimentary tract, amount of fat, presence of embryos, and the like, tend to make this figure quite variable. There are lean "chucks" in a land of plenty, as there are fat individuals in sparse cover. It is readily conceivable that we should expect to find, at times, two individuals with the same body measurements, but one weighing practically again as much as the other. This discrepancy is largely offset when we use large numbers to tabulate weights. Under discussion of food, the writer has pointed out the enormous capacity of a woodchuck's stomach. It is quite possible for this organ to hold a pound and a half of green matter at one time. It is not unusual to find over a pound of food in an animal. Assuming the stomach contents of an average woodchuck to contain half a pound, this being a very conservative estimate by repeated weighings, we must subtract this in order to determine the vital weight of each animal. Furthermore, a woodchuck carrying five embryos within a day or two of birth, would have an increase of five ounces in its weight on account of this added burden. It does not seem necessary to empty each stomach before weighing the animal, for mammals, except the larger game animals, are customarily weighed in the flesh before being dressed or skinned.

Specimens collected in the late summer and fall have an abundance of fat, this sometimes weighing a not inconsiderable amount, as compared with animals secured in the spring.

Such handicaps in using weights may tend to produce misleading results in attempts to determine age, or any other phase. Nevertheless these records are as important as the conventional external measurements.

The following weights have all been made by myself, on a dial scale, graduated to half ounces. From time to time the scale was checked with others by known weights, and proved to be quite accurate.

Monthly Weight Averages for Adult Woodchucks

					Male and Female	
		Males		Females	Averages	
Month	No.	Weight	No.	Weight	No.	Weight
March	4	5 lbs. 4 oz.	3	4 lbs. 10 oz.	7	5 lbs. 10 oz.
April	51	4 lbs. 13 oz.	38	4 lbs. 6 oz.	89	4 lbs. 11 oz.
		(6-13, 2-12)		(7-9, 2-10)		
May	70	5 lbs. 3 oz.	43	4 lbs. 6 oz.	113	5 lbs. 4 oz.
		(8-7, 3-6)		(7-11, 2-15)		
June	10	7 lbs. 2 oz.	17	6 lbs. 2 oz.	27	6 lbs. 4 oz.
		(8-8, 4-8)		(7-14, 3-8)		
July	21	7 lbs. 13 oz.	12	7 lbs. 8 oz.	33	7 lbs. 12 oz.
		(12-9, 5-1)		(9-4, 6-4)		
August	26	8 lbs. 2 oz.	21	8 lbs. 3 oz.	47	8 lbs. 2 oz.
		(11-10, 6-2)		(10-4, 6-9)		
September	9	10 lbs. 4 oz.	9	9 lbs. 11 oz.	18	9 lbs. 15 oz.
		(11-1, 7-1)		(11-0, 7-12)		

Numbers in parenthesis represent extremes for the month.

The average weights of 326 adults collected from late March to late September, during 1931 and 1932, is six pounds and three ounces. Of males, 191 adults average six pounds and four ounces, while 135 adult females average six pounds and one ounce.

Undoubtedly the weights of woodchucks that have appeared from time to time in the literature of sporting magazines have been, for the most part, those of large animals. Sportsmen usually wish to break records with their trophies, to boast of some big animal brought down by clever stalking and good marksmanship. Moreover there is an incentive to record the weights of animals killed in the fall rather than in the spring because of the greater size of these beasts. I have tried to substantiate the records of woodchucks weighing fifteen pounds by actually securing such animals, or getting such information from reliable persons who have actually weighed the largest specimens.

It is significant, that of over three hundred adult animals carefully weighed, only eleven reached ten pounds or more. The heaviest, a huge male taken on July 25, 1932, weighed twelve pounds and nine ounces. The stomach contents of this individual accounted for three-quarters of a pound.

Mr. Harold Rightmyer, who has killed well over seven hundred woodchucks in the area where this study has been undertaken, recalls that his largest specimen, an August animal, weighed just fifteen pounds. He thinks the weight of one he once shot must have exceeded this maximum.

In early October, 1922, Mr. Owen Beckwith, of McLean, N. Y., shot a very large individual. He was struck with its size and found that its actual weight was fourteen pounds and four ounces. The contents of the stomachs of such specimens might easily have weighed a pound, or even exceeded that weight. We are forced to believe that a very large woodchuck (*Marmota monax rufescens*), at least in central New York, will scarcely weigh more than thirteen pounds, while the average weight of the largest animals is usually a pound or two less.

COLORATION

NORMAL COLORATION

In the coat color of *Marmota monax rufescens* we find much variation. Essentially there are two types of hair, the long coarse guard hairs, that project considerably beyond the soft wool-like underfur. This shorter fur is quite thick, but is altogether lacking on the belly. Howell (1915, p. 25) has given a good description of the normal coloration of this form, but the variations are so great that a few may well be described. In general, throughout central New York, woodchucks may be roughly divided into two color groups. The first is a light form of a somewhat grizzled appearance, all the long hairs being tipped with light buff. The other phase, less common, is a dark form, the long hairs being tipped with chestnut brown. Individuals are often so characteristically marked that they may frequently be recognized in the field.

A large male preserved in the museum of Cornell University, No. 1157, is very dark throughout, almost black, except the sides of the face, shoulders, and flanks, the long hairs of this region being tipped with white. The animal is reminiscent of a silver fox.

The inner forelegs and chest are often a Mars orange; this bright color is less pronounced in dark individuals. Rarely the long hairs are lacking. Their occasional absence gives to the animal a decidedly woolly appearance. Two animals were taken in this condition.

ALBINISM

White woodchucks are not common, but two are in the collection of Cornell University. Both are pure albinos. I have seen about ten in all, represented for the most part in college collections.

MELANISM

The black phase is rather well developed in *Marmota monax rufescens.* No pure black specimens have been recorded. All have had the head lighter than the remainder of the body, and usually a mummy brown. Three such as this have been collected by the writer and three more seen in the field. A black individual which had been under observation had four normal colored young, while another female that was black had two black young and two normal colored individuals. Harold Rightmyer collected the two black young but did not succeed in shooting the old one, although he saw her many times. It is Rightmyer's impression that black woodchucks are far less common at present (1931-32) than they were ten years ago. In former years he used to shoot an average of fifty "chucks" a season, of which two or three would be black. During the season of 1931 and 1932 he shot nearly four hundred, and of these only two were black. Out of a number of over seven thousand woodchucks seen in the field, only six have been black.

VIBRISSÆ

The woodchuck is equipped with well developed black bristles, similar to other members of the family. These are for the most part situated on the face, in keeping with the established axiom that sense organs are usually to be found most prominently about the head and forelimbs. There are four sets of these vibrissæ on the head.

The bristles of the mystacial group are the best developed and are found on the upper lip. These normally number fifteen, and the longest average forty millimeters in length. The superciliary group, numbering five bristles, is found just above the fore part of the eye. These average from thirty to thirty-five mm. A third group, the malars, number eight prominent hairs, and average sixty mm. They are situated midway between the eye and the angle of the mouth. The interramal set of six large hairs and two or three smaller bristles measure from thirty to forty mm. There are two large carpal bristles.

MALOCCLUSION

Malformed incisors, in many rodents, are not infrequently found. Woodchucks are no exception in this respect. Many instances have been recorded where the upper and lower incisors, deflected in some manner, have grown without restraint, and have even at times effectively locked the jaws.

Of well over five hundred woodchucks observed in the flesh, five individuals, or one per cent, have been found to have well developed cases of malocclusion. The most pronounced instance of this anomalous condition is in the skull of an adult animal in the Cornell University Museum (no data). The right upper incisor forms the arc of a perfect circle, and is embedded in the palate just anterior to the first left cheek tooth. The left upper incisor parallels the right incisor for half its length, where it leaves the mouth and pushes outside, terminating thirteen mm. laterad of the infraorbital foramen. These two incisors have an average length of fifty-seven mm., while in a normal animal the upper incisors measure eleven to thirteen mm. In this same individual the left lower incisor is deflected rather sharply to the right, reaching far outside the mouth. The tip of the tooth is considerably flattened, while the length of the incisor is forty-seven mm. The right incisor is absent.

In another individual, (Plate XX, fig. 1), the two lower incisors have grown sharply to the right, the right incisor passing under the shorter left incisor. The right incisor is moderately sharp at the tip and measures forty-eight mm., while the blunt left incisor is but thirty-four mm. The left upper incisor has curved under and grown up, piercing the muscles and flesh in the region of the lachrymal canal, and protrudes here for thirty-four mm. The upper right incisor curves ventrad for a short distance, then turns upward and is imbedded midway between the anterior palatine foramina and the first left molar.

A third individual had the upper incisors missing. The lower incisors curved outside the mouth, both to the right side, for a distance of thirty millimeters.

Other instances have been recorded by the writer of malocclusion in the woodchuck, but they are not as pronounced as these.

POLYMASTISM

Normally the woodchuck is equipped with four sets of functional mammæ. Two pairs are pectoral, one is post abdominal and one pair is inguinal. Rarely does it happen that conditions differ in this respect.

Two instances of supernumerary nipples have been witnessed by the writer. It accounts for one in every two hundred and fifty woodchucks examined. In both cases the extra pair has been located between the normal abdominal and inguinal pair, and in both instances these accessory glands were functioning.

Polymastia and hyperthelia are not uncommon in man. Possibly this condition is common to other mammals. The many recorded instances in *Homo* have been the result of thousands of workers in the medical profession tabulating their data. Far fewer are at work with the smaller mammals. With further studies, we may find the presence of extra teats not uncommon in most of the smaller mammals.

MOLT

An annual molt occurs, occupying a long drawn out period from late May until early September. The young of the year molt later than the adults. Individuals born the same year may go into winter quarters in a half-shed condition. Part of the body, usually the posterior portion, may have new fur, while the anterior end may possess the juvenal coat of summer.

Upon emerging from their prolonged winter sleep, the fur of the woodchuck is long and thin, being somewhat soiled and faded in appearance. Often large bare spots appear, possibly due to the friction of the walls of the hibernating cell.

Howell (1915) says of woodchucks in general: "There seems to be no uniform method of molting, the new pelage sometimes appearing in patches on various parts of the body in an adult individual of *M. monax preblorum*, taken July 11, the new pelage coming in over the entire upperparts, farther advanced on the fore back and shoulders." This is just the reverse of what I have found in my studies of *rufescens*. Almost without exception, the molt commences with the tail. This appendage becomes thick and bright, in marked contrast to the frayed and faded body fur. Paralleling this, the new fur appears about the facial region. The hind quarters are next clothed in new fur, and this area gradually embraces the upper back region, advancing toward the shoulder, while the fur of the upper head, throat and neck are replaced with new fur, slowly retreating caudad to meet the new fur of the back. The fore shoulder and humeral region are, in general, the last parts of the animal to secure the thick new fur of late summer.

This is, in general, the manner exhibited in fifty-three individuals when collected during the molt.

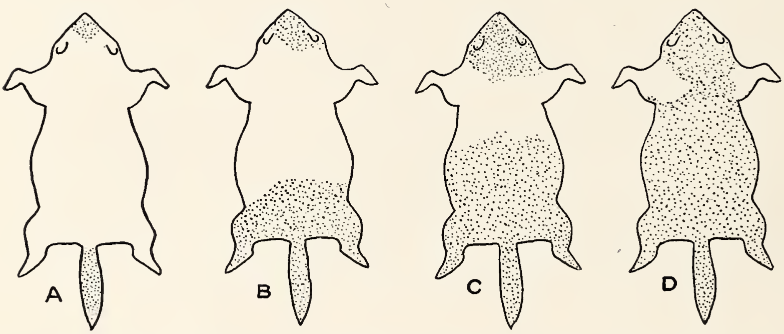


FIG. IX. Captive Woodchuck showing progression of molt. A, June 30; B, July 10; C, July 16; D, July 20.

The change of fur is accomplished by new hair replacing the old, quite irregularly, over one part of the body at a time. Practically all individuals have shown, when the molt has been well instituted, the fore part of the animal in the old fur and the hindquarters in the new. This is not confined to small spotty areas, where the molt is incipient, but rather to the whole portion undergoing a change. Thus, if we should pick up an animal half way through the molt, we should expect to find half the body (*i.e.*, the caudal half) in bright new fur and rather sharply demarked from the shoulder region.

The earliest date for a molting animal is June 12, 1932, when a large female proved to have much new fur. It is very likely the commencement of the molt was instituted in late May. Few individuals commence to shed their fur this early, but by early July the annual pelage change has commenced in earnest. Adults taken during the middle of this month have the molt half completed. There is a wide difference between certain individuals in the time of molt, regardless of the apparent condition of the animal, the amount of fatness, or any other visible factor. Of two adult individuals taken on August 1, 1932, one had completed the molt while the other had not commenced the change. On this same date, a subadult was taken that had shed far more irregularly than is common with these rodents. Two patches of old fur remained on the shoulder, while a large patch of the previous year's fur remained on the rump.

On August 6, 7 and 8, 1932, eight adults had completed the change, while eleven young had not commenced to molt. On August 12, 1932, four adults had undergone the entire molt, while of four young, two were almost through the change and two had renewed only the fur of the tail.

By early September, most of the adults have molted, and about half the young have completed the change.

In general the adults get their new fur first, then the subadults, followed by the young of the year. The young do not always renew their coat the first year, since they may have it half completed when cold weather overtakes them and they retire for the winter sleep. Thus early in the spring it is quite possible to take young animals of the previous year, with half the body clothed in long fur, the other half in the much shorter new fur of the previous fall.

Complete molting in a captive individual occupied three and a half weeks. A young individual marked and released August 2, 1932, had no new fur. When recaptured on August 19, the posteror part of the body was in new fur and the molt had been half consummated.

FOOD AND FEEDING HABITS

The following list of foods recorded as eaten by the woodchuck is in no way exhaustive. For the most part, it is from one observer's notes taken over a period of several years. As might be commonly supposed, clover and alfalfa form the bulk of the green food eaten during the summer months, but these are not necessarily the most important, nor do they serve the vast majority of "chucks." Stomach analysis of rodents is often unsatisfactory. The food, in most instances, is finely ground up and comminuted, so that certain identification is usually not definite. By emptying the contents of the stomach into a pail of water, stirring it vigorously so as to break up the compact mass, the distinegrated parts that float to the surface may readily be picked out. Frequently, enough of the leaf, flower, or stem, exists to make immediate identification possible. Smelling the mass will prove a ready means of identification for some foods, but this method is not often of much value.

Direct observation of the feeding animal is a very useful procedure in attempting to determine selected food plants. So seldom can a wild animal be watched while feeding that this method proves of great value whenever possible. Frequently animals, when shot, have a piece of vegetation in the mouth. There is little chance of mistaking such parts. About the den, the choicest vegetation is often cropped close. This likewise gives us a method which is useful.

LIST OF FOODS

Vallisneria spiralis Eel Grass. During early July, 1930, near Cedar Spring, Clear Township, Adirondack Mts., N. Y., Drs. W. Senning and A. S. Hazzard saw a woodchuck on a log jutting into a small pond. It was feeding upon this plant.

Phleum pratense Timothy. The leaves and stem are eaten.

Agropyron repens Quack Grass. The leaves of this obnoxious grass were being eaten by a large woodchuck observed in January. This is the only record I have of the animal feeding on this grass. I should like to report more.

Rumex Acetosella Sheep Sorrel. Leaves eaten, especially in spring.

Polygonum sagitatum Tear Thumb. Leaves eaten in late summer.

Fagopyrum esulentum Buckwheat. Young plants are eaten avidly. Ripening grain often forms a considerable part of the stomach contents in late August.

Ranunculus acris Tall Buttercup. Leaves commonly eaten.

Brassica arvensis Wild Mustard. Not a common food plant, yet furnishing one of the first greens of early spring. The basal leaves are eaten, and rarely the flower heads.

Barbarea vulgaris Winter Cress. The leaves are eaten in May.

Geum strictum. The leaves are eaten.

Rubus sp. Wild Blackberries and Raspberries. Stomachs of woodchucks shot in August disclosed the red remains of ripening blackberries. In many instances woodchucks travelled considerable distances from their home den for these delicacies, when all about the den succulent greens were present to tempt them.

Agrimonia sp. Agrimony. The leaves are frequently eaten.

Prunus serotina Wild Cherry. Leaves, bark, flower, and fruit. The wild cherry furnishes bark in late winter, flowers and leaves during spring, and enticing cherries in late summer. Woodchucks have been taken with a half pint of this fruit in their stomachs.

Trifolium pratense Red Clover. The most important food throughout the season. Stems, leaves, and flower heads, are eaten.

Trifolium repens White Clover. Leaves, stems, and flower heads. An important food of the woodchuck.

Melilotus alba Sweet Clover. Leaves, stalks, and blossoms are eaten.

Medicago sativa Alfalfa. Leaves, stems, and flower heads are eaten. A very important food item.

Rhus typhina Staghorn Sumach. During March the bark of this tree is frequently chewed upon by woodchucks. It is loosened by scratching with the fore paws.

Malva rotundifolia Common Mallow. Leaves are sometimes eaten.

Hypericum perforatum St. John's-Wort. Leaves are eaten in the spring and early summer.

Œnothera biennis Evening Primrose. Basal leaves are eaten in early spring.

Plantago major Broad-leaved Plantain. Plantains are eagerly devoured, the stems and leaves being for the most part sought. Often in the clover patch, woodchucks will pass by the leaves of red clover to seek out the smaller plantain, hidden beneath the larger plants. They apparently favor it to clover.

Plantago lanceolata Narrow-leaved Plantain. As above.

Plantago rugelii Red-stemmed Plantain. As above.

Solidago bicolor Goldenrod. On September 7, 1932, a "chuck" was seen feeding on the basal leaves of this plant.

Solidago sp. Basal leaves of several species are eaten.

Aster undulatus Aster. The basal leaves are eaten.

Erigeron annuus Daisy Fleabane. Basal leaves are eaten in early spring.

Daucus Carota Wild Carrot. Leaves are eaten.

Chrysanthemum Leucanthemum White Daisy. Leaves are frequently eaten. An important food in the fall.

Tussilago Farfara Coltsfoot. Flowers are eaten. An important food when in bloom.

Taraxacum officinale Dandelion. Leaves, stems, and flower heads are eaten. Without question the most important food of early spring. Captives prefer leaves of this plant to that of any other food. The principal food in the stomachs of animals collected in April and May.

Lactuca canadense Wild Lettuce. The leaves are eaten.

Hieracium aurantiacum Devil's Paint Brush. The acrid and bitter juices of this densely hairy plant are not disagreeable to the woodchuck, for I have often observed them feeding on the leaves, and specimens that have been shot have often had the leaves in their mouth.

Cirsium arvense Canada Thistle. The small young leaves of this prickly plant are found in the stomachs of woodchucks upon occasion.

Hickoria sp. Hickory. The bark of young hickories is sometimes sampled in early spring.

Acer sp. Maple. The same applies to this plant.

Oats, wheat, and corn, are among some of the grains that are principally eaten. Among the truck crops, beets, carrots, peas, beans, tomatoes (one record), lettuce, celery, cabbage, and turnips, are consumed. Melons are frequently attacked, while strawberries and cultivated cherries are eaten avidly. Apples form an important part of the diet in late summer and fall.

The animal food of woodchucks accounts for only a small portion of the fare, considerably less than one per cent. Woodchucks have frequently been accused of chasing, killing, and eating poultry. How often they are a contributing factor in the death of chickens it is difficult to say. However, there can be but little question that they sometimes eat young birds as most rodents would, if given the opportunity. Yet the nests of song sparrows, meadowlarks, and pheasants, together with other ground nesting birds, have been readily available to a number of woodchucks I have had under observation. To my knowledge, the young birds were never molested by these large rodents. Hatt (1930) found a nestling bird in the stomach of a woodchuck.

On October 6, 1932, a woodchuck was collected that had badly malformed incisors. In the mouth and stomach were a score of snail shells (*Heliosoma antrosa*). Possibly the woodchuck had to feed on these molluscs because of the difficulty experienced in eating green matter. Furthermore, it is possible that shells were an aid to digestion, as the animal could do little chewing with such a bad case of malocclusion.

Woodchucks occasionally eat insects. Two animals had fed sparingly on grasshoppers (*Melanoplus femur-rubrum*) while June bugs are sometimes eaten (Gianinni, 1925).

It is customarily assumed that flesh eaters have relatively short intestinal tracts, while the entera of herbivores are proportionately longer. Some clue may be given us to the woodchuck's carnivorous tendencies by comparing the length of the intestinal tract with that of other rodents where the food habits are likewise relatively well known. Two flesh eaters are included for comparison. The measurements are in inches, and the figures represent two individuals in each instance.

SPECIES	INTESTINAL LENGTH	BODY LENGTH	RATIO OF INTESTINAL LENGTH TO BODY LENGTH	TYPE OF FOOD
Weasel (*M. cicognanii*)	40	10	4 to 1	Carnivorous
Skunk (*Mephitis nigra*)	79	15	5.3 to 1	Omnivorous
Grey Squirrel (*S. carolinensis*)	102	10	10.2 to 1	Herbivorous
Red Squirrel (*S. hudsonicus*)	57	7.7	7.4 to 1	Chiefly herbivorous. Eats meat on occasion
Woodchuck (*Marmota monax*)	222	18	12.3 to 1	Herbivorous

AMOUNT OF FOOD EATEN

The stomach contents of 146 animals have been weighed in the field. These average 8.6 ounces, or slightly more than a half pound. The vast majority of the animals were shot while feeding, so this is not altogether a true index of the amount of food the woodchucks might have consumed. Many of the animals had but three or four ounces of food in the stomach. We know that an adult woodchuck's stomach is capable of holding more than a pound and a half of green matter.

Nine of the above individuals had more than a pound of matter in the stomach, while one had eaten twenty-six ounces of food. Young animals usually had more in their stomachs, proportionately, than the adults. The animal with the stomach contents exceeding a pound and a half had a gross weight of six and a half pounds. Without food, this animal weighed not quite five pounds. Thus it will be seen that it had eaten just one third of its weight. A subadult male taken on April 24, 1931, had eaten thirty-five per cent of its body weight, while another male, collected on May 6, 1932, had eaten twenty-nine per cent. Frequently we have taken woodchucks, whose stomach contents would have equalled a quarter of the animal's weight. Probably a pound a day in green matter is necessary to keep a woodchuck fit. An adult sheep will eat from nine to ten pounds of green matter daily.

TIME AND MANNER OF FEEDING

The greatest amount of food is consumed during the late afternoon hours. Woodchucks commonly feed during the early morning, and while they may appear at irregular intervals throughout the day for feeding purposes, the hours from 5 P.M. until dark are the most active ones. Young animals, growing rapidly in the late summer, are apt to make use of almost any hour. Animals that have been shot at, repeatedly, feed entirely in the early morning or do not commence their feeding until dusk has made accurate shooting impossible.

Woodchucks employ their fore paws in feeding on the taller plants, such as red clover, alfalfa, grains, berries and leaves. The part desired is secured with one fore paw, pulled toward the animal and devoured. With apples, peas, and beans, they may hold the food in both hands while feeding.

ENEMIES

The woodchuck, because of its size, has few foes. Most of these it can guard against by a hasty retreat into its underground labyrinth, but occasionally it is outwitted by one of the larger mammals.

Of vertebrate enemies, the fox, man, a few hawks and owls, and an occasional snake, are the principal foes with which the groundhog has to contend. Among the lesser enemies—the parasites—I have found two or three external forms and as many internal pests.

RED FOX

There can be but little question that among the larger animals, not barring man, the red fox ranks first as a destructive agent of the "red monk." The breeding season of this valuable fur-bearer closely coincides with that of the woodchuck, and young foxes are fed in large measure upon the meat of this rodent, where it is at all abundant. At this season, the home den of a red fox may be literally strewn with the remains of woodchucks. Two fox dens visited by the writer in May had a large representation of these animals about the hole. Mr. John D. Smith, of the Boston Society of Natural History, informs me that by actual observation, he ranks the woodchuck as the most important food of these red-robed fur-bearers during the spring and summer months. Repeatedly he has found the partly eaten carcasses of woodchucks in the area about the dens, which are particularly abundant in the Boston region. It sometimes happens that the fox will kill a groundhog, find the den of the dead animal to its liking, and with a little effort, enlarge the burrow and make its home there.

MAN

In all likelihood, man kills more "chucks" than the fox. Because of his cultivated fields, acres of clover and alfalfa, and unfavorable attitude toward the fox, however, he compensates in large measure for the havoc he does with trap and gun. In some areas man carries on incessant warfare with the marmot, but in other parts of his range, the woodchuck is almost unmolested. Dogs, because of man, are distributed widely throughout the woodchuck's range, and take a large toll. The clearing of the forest by man, with the resultant large acreage of open fields and meadows, and rolling country devoid of trees, has done much to encourage the woodchuck. His range has spread widely over this rich domain.

SNAKES

One of the state gamekeepers of Pennsylvania (Pennsylvania Game News, Aug. 1931, Vol. 2, p. 5), killed a large rattlesnake, in the stomach of which were two young groundhogs, respectively six and eight inches in length.

INTERNAL PARASITES

I have repeatedly made blood smears of woodchucks and critically examined the corpuscles after staining, in the expectation of finding unicellular organisms. None have ever been encountered, but probably from time to time throughout its life span the woodchuck is host to the invasions of many protozoans.

Among parasitic worms, nematodes appear to be most abundant in the intestinal tract, more especially in the rectum. These small threadworms, almost colorless, may number several hundred in an individual, but more often fewer than a score are to be found.

In the stomach, one sometimes finds a number of small, red roundworms, attached to the mucuous lining. More often they are absent, and they never reach the abundance recorded in the skunk and the fox.

EXTERNAL PARASITES

Among the ticks, only a single species has been determined, that being referable to *Ixodes hexagenia* var. *cookei* Pack. Practically every woodchuck I have examined has had these ticks present, sometimes in considerable numbers. As many as 69 specimens have been taken from one woodchuck and probably many more were overlooked. Apparently no particular place is sought for their attachment, unless it be the axillæ and sternal region, where they are most frequently encountered. Woodchucks do not appear to be unduly disturbed by these little demons. The groundhog is not their only host, for the ticks will quickly attach themselves to man, where the capitulum is soon buried. If this structure is not removed when the tick is destroyed, serious results may be expected. The writer was the temporary host for one of these arthropods on September 5, 1931. A tick attached itself to the anterior bend of the right elbow, and was removed shortly afterward, but not without leaving a small piece of the capitulum. A year later the site of the tick's attack still remained visible, while pruritus caused much discomfort over a wide area about the site. In three instances children have been utilized as a host by *Ixodes*, which may live for a long period without feeding after removal from the normal host. In the case of the children, no serious effects were felt, but the animals were removed in a very short time after their attachment to the human host. Great care should be exercised in handling these rodents, because of the likelihood of getting these arthropods on one's person.

Most woodchucks have their allotment of fleas. While several hundred have been taken from the animals, all prove to be one species, *Ceratophyllus arctomys* Baker. It is most frequently seen about the anal region and the head, but possibly observation for parasites is much easier in these areas of shorter fur or less hair. What has been said of the tick regarding its attacks on man, might be repeated here. It has the pernicious habit, common to all fleas, of taking a nip here and another there. Its uncommon ability to escape detection or to elude pursuit makes it a most undesirable tenant. It may be extremely abundant on one animal, and entirely lacking on another. I have taken over twenty fleas from a single woodchuck, and missed as many more.

CUTEREBRA

Seton (1929) says of the woodchuck, "Even the *Cuterebra*, for some strange reason, lets it alone." Such is not always the case. An adult collected on July 24, 1931, had a bot larva 14 mm. long on the right side of the head, below the right ear.

A young woodchuck, taken August 17, 1932, had a Cuterebra larva completely plugging the right nostril and filling the nasal passage, enlarging that area enormously, and had at the same time the left nostril almost closed, because of the pressure brought to bear upon it. Yet the "chuck" appeared to be in good condition, and was as large as an average young animal of that date.

These are the only two individuals among five hundred that exhibited the effects of this enormous fly larva.

A QUESTIONABLE PARASITE

A curious little grey fly of the genus *Pegomyia*, not unlike a house fly, but considerably smaller, is found in abundance on practically every "chuck" collected in the summer. It is a member of the family Anthomyiidæ, calyptrate flies of leaf-mining habits. With binoculars, one can commonly see woodchucks sunning themselves and observe these flies crawling about rather aimlessly on the fur. More than a hundred may sometimes accompany a single individual. It is this insect that makes the "chuck" paw at his face, shake his head and at times appear ill at ease. Especially is this true when the infestation is very pronounced. It is a curious relationship, and I cannot account for the connection. Possibly the fly gets food from the dry dead epidermal tissue common to any woodchuck's hide, or it may secure some moisture from the rodent.

HIBERNATION

The subject of hibernation has received a great deal of attention, and voluminous reports dealing with the subject have been written. Yet we are still far from an exact knowledge of the cause of this phenomenon. Many explanations have been accorded it, but few have stood the trial of time.

CAUSES OF HIBERNATION

Much experimentation and elaborate hypotheses have been promulgated concerning the motive for hibernation. The principal arguments as to the direct cause have been those of lack of food and low temperatures. We cannot attribute either of these to the disappearance of a large percentage of the woodchuck population during late September. The warm days and cool nights of Indian summer have but begun, and the fields are clothed in tender plants, succulent and green because of the autumn rains.

Apropos of this annual call to the earth, we might review a few of the suggestions of other workers. Much is pure speculation, while more is the result of careful observation. Simpson (1912) carried on experiments with woodchucks and decided that food was the controlling factor, because animals supplied with an abundance of food did not hibernate. Fatness in ground squirrels and marmots induces hibernation, states Cleghorn (1910), who does not consider lack of food a contributing factor. In his detailed studies of the Columbian ground squirrel, Shaw (1925) is certain that both hibernation and aestivation are brought on by a lack of water and green food. Rasmussen (1915) verified the studies of DuBois (1896), who concluded that autonarcosis was the principal cause, induced by an excessive amount of carbon dioxide in the blood and tissues.

That the reduced size of the pituitary body during hibernation is the result of physiological inactivity and therefore the principal cause of the profound winter sleep has been held by Cushing and Goetsch (1913). Both Rasmussen (1921), by his experiments with hibernating woodchucks, and Mann (1916), with striped ground squirrels, found no evidence to support the theory of Cushing and Goetsch. Later Rasmussen (1923), and Sheldon (1924), found the so-called "hibernating gland" to be a form of fat, having nothing to do with the winter sleep.

Finally Wade (1930), with characteristic thoroughness, has carried on elaborate studies of four species of western ground squirrels. He found captive ground squirrels hibernating equally well in rooms with a high relative humidity and with very dry air. Squirrels supplied with an abundance of water and moist foods had hibernated. Squirrels hibernated in well lighted rooms, while others remained awake and active in darkened rooms. Animals in well ventilated rooms became torpid, disproving the importance of confined air as a necessary condition for torpidity. One of the contributing factors inducing hibernation, Wade believes, is the relative fatness of the animal. When they become very fat they approach the lethargic state.

I cannot help but believe that this latter view,—the accumulation of a necessary amount of fat,—is a contributing cause, if not the paramount reason. It is readily observed that young woodchucks, of the year, are always the last to be abroad in the fall, and are the lean ones, sometimes practically devoid of fat. For that very reason they possibly do not have the urge to become lethargic and to commence the period of somnolence. Their food has been converted into growing tissue, thus prolonging the deposition of adipose tissue. I have observed the same to be true of jumping mice (*Napaeozapus*), the young always hibernating later, and being with less fat than the adults. This probably accounts for the animal's presence later in the fall. It must put on a protective coat of fat to withstand the long period of dormancy and, for that very reason, is abroad later in the season to accomplish that end.

PERIOD OF ENTRANCE INTO HIBERNATION

The dates of entrance into hibernation have been set for this animal by many writers. Perhaps the most enlightening of these accounts has been set forth by Merriam (1884), in his classic paper on the mammals of the Adirondack region, who has this to say:

> "Along the western border of the Adirondacks he goes into winter quarters between the 18th and 25th of September, not to reappear until the middle or latter part of March. It is indeed a curious coincidence that the limits of the dormant state should so closely correspond with the periods of the equinoxes. In nine cases out of ten, he disappears with astonishing precision, within a few days of the autumnal equinox, and remains under ground until about the time the sun cuts the plane of the equator at the vernal equinox.
>
> For this rule, there are, of course, exceptions, but they are not sufficiently frequent to in any way invalidate the accuracy of the above general statement. During very warm weather it sometimes happens, that a woodchuck may be seen sunning himself at the mouth of his hole for an hour or two in the hottest part of the afternoon as late as the first of October, but such instances are rare. In the early springs that sometimes follow exceptionally mild winters, woodchucks occasionally appear in February, but re-enter their burrows and again become dormant if the temperature suddenly falls. In southern New England

they commonly remain out until late in October and I have seen them in the Connecticut Valley even in November."

Seton (1929) regards the annual subsoil trip to be scheduled for September 30, in Connecticut, a little later in Maryland and somewhat earlier in Maine. The latest appearance recorded by this naturalist was October 17, 1908. Cram (1910) relates the trapping of one which was active on November 1, in New Hampshire.

About Ithaca, New York, the woodchucks begin their voluntary seclusion as early as mid-September. On September 20, 1932, I was in excellent territory from 4:30 P.M., until dark, and saw not a single animal. A week earlier, a dozen could have been sighted in this same area. On September 21, 1932, a single individual was observed feeding from 6 to 7 A.M.

A year earlier, "chucks" did not become scarce until the 27th of September, yet six were seen on this date. A week later (1931), Mr. Harold Rightmyer was in the field from 9 A.M. until 3 P.M. He was hunting "chucks" at this time, and collected six of twelve that he saw. All of these were young of the year. He further stated that in the past ten years he has seen "chucks" frequently after the rabbit season (October 15) had opened.

A young individual was seen on October 10, 1931, twice on the 13th, once on the 19th, and the last time on the 26th. On November 6, 1931, Edward Drake brought me a trapped woodchuck that he and his brother Ralph had seen the previous evening. They chased it into a hole, where their dog attempted to dig it out. A trap placed at the entrance to the hole caught the animal the following morning. It froze hard during the night, with cold wind and snow flurries. Apparently the "chuck" was not in his own home burrow, for in all probability he would not have ventured forth in such inclement weather. The latest records for 1932 are October 26, and November 15, 1932. Mr. Ralph Percy of Trumansburg, N. Y., caught one in a skunk trap on this later date.*

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*Late fall records for 1933 are not numerous. On October 19 Robert Hart saw a woodchuck near Ithaca, N. Y. The animal was nearly one hundred yards from the den.

On October 26, 1933, two woodchucks were seen near Wilseyville, N. Y., late in the afternoon. The temperature reached 26° F. the previous night, with occasional snow flurries.

EMERGENCE FROM HIBERNATION

Merriam, in his inimitable way, has alluded to the remarkable circumstances surrounding the woodchuck's disappearance in the midst of a land of plenty, and his spring advent marked by a foot of snow and a notable absence of green food.

It is difficult to say at what date the woodchuck blunders forth, to nose about and retreat, and at what time his permanent appearance is assured. Some figures may throw light on this. I kept detailed records of all woodchuck activities during 1931 and 1932, and was in the field almost daily during February and March of these years, if only for a short time each day.

In 1924, following a normal winter, I saw an animal on February 21, near Turkey Hill, Ithaca, N. Y. Mr. Henry Reed saw one on the same day.

During the late winter of 1931, following a normal season, tracks were observed in the snow on February 22. Benjamin Rightmyer saw tracks of this animal the following day, while Harold Rightmyer, stationed at Old Forge, N. Y., in the Adirondacks, observed tracks on the 25th. On March 10, Mr. Fred Keating saw two woodchucks on Connecticut Hill, near Ithaca, and many freshly opened burrows on March 8. There was considerable snow on the ground at this time.

On March 14, 1931, while an average of four inches of snow covered the ground, woodchuck tracks were everywhere. At this date, from all appearances, they were above ground for the season.

Our records for 1932 are more complete. Following an exceptionally mild winter, with the warmest January recorded for New York State in 37 years, February was ushered in with much snow and low temperatures. I was in the field at least twenty days during this month, yet the first "chuck" sign was observed on February 26, following a previous mild night, with temperature rising to 46° F. Many holes were opened this day, and animals in general roamed about a great deal.

On March 7, 1932, a terrific snowstorm, lasting three days, caused huge drifts in the hedgerows and covered the ground to a depth of more than a foot. It snowed sporadically a bit each day, until the 17th. The temperature ranged from 10°-20° F. daily. On March 12, during a period of falling snow, woodchucks were abroad, and on March 17, many tracks were seen leading into burrows four and five feet under the snow. From this period onward, in spite of temperatures ranging from 17°-22° F., hardly a night passed but that signs were encountered of these animals.

CONDITION OF ANIMAL BEFORE, DURING, AND AFTER HIBERNATION

By early July, adult woodchucks have commenced to assume a layer of fat, in anticipation of the coming winter sleep. Their weights show a marked upward acceleration, and the lustrous, sleek appearance of well-fed animals has been assumed. With the new fur, the animal looks altogether different. The first fat is laid down in the inguinal region. This spreads out and covers the hind legs, more especially the upper or outside portion. While fat works over the rump, and also commences on the shoulder, the two regions are joined finally by a common layer. The region of heaviest coating lies over the hind legs and rump, where it reaches a thickness of more than half an inch (14 mm.). Coincident with this is a rapid proliferation of fat about the genital organs and kidneys. When the animal is ready for hibernation, the internal organs, caudad to the diaphragm, are concealed in a white mantle of fat. This fat is not as pronounced on the belly.

No food is stored. The woodchuck trusts to this storehouse of energy on its person to furnish it what little sustenance it will need when the long nights of winter approach.

During the long winter rest, the woodchuck's vital functions are at a low ebb.

Body temperatures drop as the animal becomes inanimate and sleep overcomes it. Rasmussen (1915) found the temperatures of hibernating woodchucks to range from 6°-14° C. This bridged the period from December 5 to February 27. A captive female, secured in January, 1932, while away from the hibernating den, was active in an outdoor cage most of that month. With the advent of cold weather in early February, the animal went into a profound lethargic state, and the rectal temperature ranged from 8°-17° C. The air temperatures averaged between 10° and 30° F. over most of this period. During January, with the cold nights, the animal was not especially active, but did attempt to escape on a number of occasions. During this period the rectal temperatures averaged 22°-24° C.

While hibernating, the woodchuck is rolled into a ball. The head, resting far underneath the animal, is placed between the hind limbs, so that the nose is brought into contact with the inguinal region. The forepaws rest underneath the animal and are more or less clenched. If the animal is in a profound torpor, it does not respond to touch.

Respiration is at a low ebb in the sleeping animal, and cannot be detected without instruments. If in a deep sleep, the animal does not awaken readily. When it does come forth from this profound lethargy, the time required is usually directly dependent on the atmospheric temperature. In a warm room this is hastened, while if the natural conditions under which the animal has been sleeping persist, the process may take several hours. Shivering usually accompanies this awakening, and the violent trembling is accompanied, in ground squirrels, and probably woodchucks, by a pronounced rapid rise in the body temperature.

It is generally considered that homoiotherism is restricted to birds and mammals. In the lower mammals, including the monotremes and to a lesser extent the marsupials and edentates, the internal control of body temperatures is less effective than among the higher forms. Recently Wade (1930), in his studies of ground squirrels, found normal, active animals to have a range of nine degrees centigrade (30°-39° C.). Spring temperatures averaged higher than fall or winter records.

During the active season for woodchucks in the years 1931 and 1932, I took rectal temperatures of many adult animals. Some were captive, others were trapped individuals. Care was taken in all instances to keep the animal as much in a normal state as was consistent with the act of inserting the mercury bulb well into the rectum. All but nine records have been discarded, because the animals struggled in one way or another to make the readings unduly high or untrustworthy in some manner. The average reading for these nine was 37.4° C. The lowest record was 34.9° C., while the highest was 40° C., a variation of 5.1° C. Young animals had a somewhat lower reading than adults.

In all instances, a clinical thermometer was thrust deep into the rectum, and the temperature recorded when the mercury became stationary.

LOSS OF WEIGHT DURING HIBERNATION

The long sleep is not without its pronounced effect upon the animal. Chief among these is a very considerable loss in weight. I have not taken weights of individuals during different periods of their dormancy, but the average September weights, and those secured in March, when compared, are as good an index as one could wish.

Combining the average weights of 28 young and 16 adults collected during September, we have the average individual weight of 7 lbs,. 11 oz. Of 7 specimens collected in March, including young of the previous year, now subadults, and old ones, the weights average 5 lbs., 1 oz. Here is an average loss of 2 lbs., 10 oz., or of one third the original weight. If only the adult weights of the previous fall are averaged, a weight of 9 lbs., 4 oz., for 16 individuals is secured. Four adults taken in late March averaged 5 lbs., 9 oz. This results is a loss of 3 lbs., 11 oz., or nearly forty per cent of the original weight. In early April I took a gravid subadult with two embryos, that weighed 2 lbs., 10 oz. Certainly she must have lost half the original weight during the periods of hibernation, and of early spring food scarcity. The fasting period, then, accounts for a loss of weight ranging from one-third to nearly half of the fall weight. This loss is distributed over from four to five months.

Site of Hibernation Den

In choosing a suitable burrow, or site in which to spend the winter, woodchucks usually seek a hedgerow, woods, or a steep incline in stony ground that has a southern exposure.

Merriam (1886), writing of the selections made by woodchucks in the Adirondack region of New York, gives substantial evidence to support his claim that "chucks" commonly hibernate in the woods. He says, in part:

> "It may not be amiss to acquaint my readers with the reasons that lead me to believe that the majority of our woodchucks desert the meadows in autumn and hibernate in burrows in the woods. There are two facts, either of which is sufficient, in my opinion, to establish the existence of this habit. First, as will be hereafter shown, woodchucks, in this region, come out of their burrow in early spring, two or three weeks before the disappearance of the snow and may easily be tracked to their holes. Now it has been my experience (an experience covering at least fifteen years) that fully 99 per cent of those that appear before the snow goes in the spring, come from holes in the woods. Second: In the fall of the year I have opened a number of meadow burrows which I knew were inhabited up to a week of the time when the animals went into winter quarters, and almost without exception, such burrows have been found to be tenantless."

Snow lingers longer in the woods than in the open fields and meadows. Perhaps, for this reason, animals wintering in the fields would not be so likely to leave their telltale tracks upon emerging. However, in central New York, where all habitats are available except the heavy forests of the Adirondacks, my observations agree with those of the veteran naturalist, Merriam.

By observing all available signs in the fast melting snows of March, we have found the greater number leading from the burrows of hedgerows, composed principally of wild cherry, sumach, and elders. In the area studied, nearly three-fourths of the signs have pointed to this habitat as the principal winter quarters of woodchucks. Next in order are stands of mixed hardwoods, but the occupied dens border the edge of the woods, rather than some distance within the timber.

I have never seen tracks in late winter leading from open pasture land, but an individual collected in January, a large female, had hibernated in a shallow burrow in an open field. Woodchucks frequently move from the woods and establish their spring home on sunny hillsides with a southern exposure, possibly in anticipation of the ever increasing warmth of the sun, with its effect on sprouting greens.

Frequently dens are opened at an early date in pasture lands, but in all likelihood they are tenanted by animals that have travelled from the woods and hedgerows a week or two previously.

Clumps of elders, isolated in open pastures, are frequently resorted to for the winter sleeping site.

Holes are not always chosen for the winter sleep. Mr. Clark Breed, of Perry City, N. Y., says he once opened a large straw stack in an open field. Eight or ten woodchucks were found hibernating within it. Mr. Otis Brayman, of Penn Yan, N. Y., found a woodchuck that had burrowed into a large straw stack and had rolled itself into a ball near the top. It was uncovered on December 20, 1931.

INCOMPLETENESS OF TORPIDITY

In the eastern United States, with one exception (jumping mice), the woodchuck is the most profound hibernator of all mammals. Bears, chipmunks, skunks, bats, and the raccoon, all hibernate to a lesser extent and it is not uncommon in the region of central New York to see the lesser of these creatures, not omitting the bat, active during warm spells of December, January, and February.

With the mild spells common to mid-winter, even groundhogs forsake their burrow and move about. With a drop in the temperature, they resume the profound sleep which is so characteristic during the cold months.

A few examples will suffice to illustrate the extent of their winter wanderings. It must be remembered that these are the records of only a few people over a very limited part of the animal's range. Undoubtedly it is much more active at this season than is commonly believed.

DECEMBER RECORDS

Henry Reed, a farmer residing two miles east of Ithaca, saw a woodchuck the last week of December, 1924. On December 24, 1931, Mr. Charles Van Fleet, of Perry City, N. Y., saw a woodchuck. On the same day, Miss Edith Smelker saw a "chuck" near Dayton, Ohio. It was observed in the mid-afternoon, when the temperature was 40° F.

JANUARY RECORDS

Woodchucks were abroad during much of January, 1932, when an exceptionally mild winter prevailed throughout New York State. On the 7th, Mr. Wm. Mosher, of Perry City, N. Y., saw a large woodchuck feeding on quack grass, which had remained green throughout the winter. He chased the animal into a shallow burrow, where he quickly dug it out, and later presented it to me. The temperature during the previous night rose to 54° F., and was five degrees lower when the animal was first observed.

On January 13 and 14, 1932, many "chuck" holes were opened by these animals, showing that they were generally quite awake at this time. The temperatures, from noon of the 13th to noon of the 14th averaged between 49° F. and 67° F., exceptionally warm for these dates.

On January 24, 1932, the temperature ranged from 34° to 40° F. throughout the day, with a slight fall of snow during the late afternoon. Numerous holes had been opened on this date.

Aside from these records, the press contained many short notices regarding winter activities of woodchucks, notably during the month of January, 1932.

OTHER ANIMALS ASSOCIATED WITH HIBERNATING WOODCHUCKS

Mr. Benjamin Rightmyer, who has dug many skunks from their dens before this practice was prohibited by law, has frequently found woodchucks in the same burrow as skunks, but in different chambers. Mr. Lloyd Herholdt collected a large woodchuck on March 22, 1931. From the same burrow he had taken three skunks earlier in the season. It was his opinion that all were living amicably together. Mr. Charles Van Fleet, about Perry City, N. Y., has dug woodchucks out of burrows he knew to be occupied by skunks.

Mr. Wm. Mosher recalls having found a woodchuck in a hollow stump. Separating the "chuck" from a large dormant rattlesnake were some dead oak leaves. The locality was western Pennsylvania. In fact, the sudden onset of hibernation often produces strange bed fellows, friends and enemies, predators and prey.

ECONOMIC IMPORTANCE

The woodchuck commonly plays a significant role in the economics of the farm. He is at once a minor asset, and at the same time a scourge.

DEPREDATIONS

The groundhog, in relation to agricultural interests in the east, may at times play a significant part. Fond of beans, peas, cabbage, and other garden vegetables, he becomes a serious pest to the truck farmer. Repeatedly I have seen the havoc wrought in the garden patch by this large rodent. It is to the small gardener that the most serious losses come. New beans never have a chance when once discovered, and a row of plants, six inches high and twenty feet long, is an average days feed for an individual. "Chucks" are adept at shelling peas when the vines have become too tough to manage, but young pea plants are apt to suffer greatly. Mr. Ernest Mills, of the Rodent Control Division, U. S. Biological Survey, writes me concerning the depredations of woodchucks in Massachusetts. He says, in part, "Mr. J. Lawrence, Carlisle, Massachusetts, reports that in 1926 young cauliflower plants numbering 4000 were eaten by woodchucks."

I have definite records of the woodchuck feeding on celery, pumpkins, melons, squash, and carrots in New York.

Woodchucks frequently invade the corn patch, when in the milk stages, and destroy much which they do not eat. I witnessed several rows of field corn, some sixty yards in extent, that had been rifled in part of the ears. These had been partly eaten, but for the most part had simply been torn off and trampled. The corn was growing in a situation ideally situated for woodchucks. The field was far removed from the habitations of man, and the scope of their invasion faced a sloping hillside liberally tenanted with these animals. Undoubtedly the injury in part may have been the work of raccoons or skunks, both of which were well represented in a nearby woods. However, woodchucks were seen working in the corn, and it is not unlikely that they were the worst offenders.

Grains of all kinds are favored by this animal. The tender leaves of sprouting buckwheat are devoured, and the ripening grain of this same plant often distends the stomachs of individuals collected in August. Much of that which is not eaten is trampled down so that it cannot be cut.

Oats, and wheat, but more especially the latter, are treated in the same manner as buckwheat. Howell (1915) quotes Bailey, who has seen nearly an acre of oats ruined by a family of woodchucks, their trails having broken down most of the grain which they had not cut to eat.

Aside from their nefarious inroads on foodstuffs, "chucks" are guilty of other faults. The burrows made by this animal are a hazard to safe mowing, the sickle bars of the mower often being dulled or broken by the hidden mounds which the tall grass often covers. Horses, unaware of their holes in the meadow or hayfield, suffer broken legs. Large areas are of necessity left uncut because of the sprawling mounds of stone and hardened dirt at the mouth of the entrance hole.

The woodchuck has been accused of being responsible for cave-ins of railroad embankments and breaks in levees, with the resultant flooding and subsequent erosion that often follows such breaks.

As a destroyer of fruit trees, especially when these are young, the woodchuck plays a not inconsiderable role. J. A. S., writing in the "Rural New Yorker" for July 23, 1932, says, "I noticed the trunks of my two year old peach trees were badly scratched by woodchucks."

It would not be hard to give further damning evidence of the woodchucks' destructiveness. Many facts might still be piled up to show his inimical nature. But I am in haste to show the "Dr. Jekyll" side; the good he is capable of and the benefit we experience from his presence, for I like the stolid little fellow of the meadow.

HIS BENEFITS

In spite of his disgraceful conduct at times, the groundhog has many redeeming attributes that stamp him, indirectly, as a friend of man. His very energy and tireless efforts result in the construction of many more burrows than he can use. These are in turn invaded by skunks, foxes, rabbits, and a host of other mammals. We may not think of these animals as an asset, but they bring a sizeable return to the state through the sale of hunting and trapping licenses, and in turn furnish a partial livelihood to thousands of men, both young and old, throughout the state.

Rabbits seldom dig, but resort to the burrows of other animals. Skunks are loathe to construct their own homes when a convenient woodchuck burrow may be easily remodeled. Foxes, as has been pointed out elsewhere, not infrequently usurp a tenanted woodchuck burrow, or make over a deserted system of tunnels, originally planned and executed by the woodchuck. Weasels, which are a far greater asset than has commonly been realized, utilize the shelter of woodchuck burrows for breeding purposes. Many other forms stay in the burrows of these creatures for short periods.

As a source of food, he is not without merit. Young woodchucks, properly prepared, are a joy to many country folk. Adults are prepared for winter use by the foreign rural population of central New York. Mr. Joseph Lisseck of Ithaca informs me that the Italians living near Danby, N. Y., frequently can woodchuck meat, preparing it in two-quart fruit jars for winter consumption.

The fur of the woodchuck is of little value, as it is thin, coarse, and not especially durable. The few coats I have seen made up of these skins were of spring pelts. If August or September animals had been used, and some care exercised in the matter of matching pelts, a fair garment, not unattractive, would result. Formerly the hide was tanned, and the tough skin made into straps or lacings for various uses on the farm. They are seldom used, even for such purposes, today.

The woodchuck's greatest value, from the viewpoint of the hunter, is the sport it furnishes. Woodchucks furnish more shooting, with a rifle, than any other mammal in the east, not excluding deer. They are the most abundant mammal, for their size, throughout settled districts. A wary animal at the height of the best shooting season, July, August, and September, they offer a small mark from a long range. A head shot is usually necessary to stop the animal; less frequently, a bullet in the chest will kill it outright.

Both young and old are suspicious after the first mowing has been completed, and with less cover in which to hide, they utilize the early morning and late afternoon hours in which to venture forth. All individuals are not exceedingly wary, if they were the writer would never have had the large numbers to study that have been at his disposal.

It cannot be denied that all burrowing rodents play a considerable role in the formation of soil. Removing to the surface, as they do, the subsoil, stones, and inorganic matter in general, where the action of wind, rain, and frost, can work upon them more readily, it is inevitable that the period when such substances are transformed to finer, richer particles will be materially hastened.

In the west, where gophers, ground squirrels, and kangaroo rats, abound, this consideration is an important one. In his enlightening account of the burrowing habits of California rodents, Grinnell (1925) has shown that gophers will transport to the surface over seven tons of earth per square mile annually, where the animals are well represented. The same writer estimates ten burrowing mammals to the acre, as an average throughout the state. We have nothing paralleling this abundance in the east. Our commonest fossorial mammal, whose work is relatively obvious, is the woodchuck. In the southeastern states, where they are numerous, moles may play a factor in soil formation, but not on so grand a scale as those burrowers of the west.

Woodchucks are perpetual diggers. Their burrows are met with everywhere, when the animals are at all numerous. This tunneling brings stones, pebbles, clay, and sand to the surface, dependent on the type of soil in which they are working. This industry has a twofold effect on the surrounding terrain.

First, the subsoil, being exposed to the elements, has an increased opporunity to become weathered, and transformed into arable land; secondly, air and water have freer access to the tunnels, where they may work together on the subsoil, breaking it up and comminuting large pieces. This all has a direct effect on the vegetation, resulting in increased growth.

We may assume that there is at least one woodchuck to the acre over that part of their range in New York State where they are numerous. Each animal will bring to the surface, as determined by actual measurement, an average of two hundred pounds of dirt and stone during a single season. This gives a total of 128,000 pounds of subsoil transferred to the surface per square mile annually, where the atmospheric elements may get in their work of breaking up the particles. In other words, if we assume half of New York State, with its boundaries encompassing nearly 50,000 square miles, to harbor one woodchuck to every acre, we arrive at the astounding conclusion that over 1,600,000 tons of earth is removed to the surface each year. This is the equivalent of 32,000 loaded carloads each of fifty tons capacity. In some parts of the animal's range the amount of turnover is far in excess of the average, while large areas are devoid of all but a very few animals. The heavily timbered Adirondack region is a good example of the latter.

CONTROL METHODS

Essentially, there are three practical methods in vogue to keep the woodchuck population in check. Shooting, the use of gas in the burrows, and trapping, all have resulted in lessening their numbers for a short period. None of these, nor all combined, can ever exterminate the animal over a suitable range, or even materially reduce their numbers.

Shooting is, to the writer's mind, the most effective method of control. It must be understood that a good rifle, sound ammunition, and a capable marksman, all combine to make this method one of great destructive potentialities. The ideal time in which to carry on a warfare against this rodent, as it is with most rodents, is during the breeding season or somewhat previous to this, prior to the birth of the young. This covers a short period in early April in many instances, for young are born at any time during April and early May. To be effective, a head shot must be scored, for a woodchuck, possessed of remarkable recuperative powers, will survive a bullet wound almost anywhere else. A good rifle of .22 calibre is satisfactory, but one of a larger bore, such as a .25-20, a .32-20 or even a heavier weapon is more efficient. Telescope sights are an asset, as they prevent many misses and crippling shots. Woodchucks are remarkably free from suspicion in the early spring, and will show themselves repeatedly although they have been fired at, again and again, without results.

The use of carbon bisulphide and calcium cyanide are both effective when gassing procedures are to be used. The former is placed on a piece of waste, cotton, or other absorbent material, three or four tablespoons being sufficient. Care should be taken to seal effectively the entrance to the burrow, using caution that no earth or other matter falls on the wad. Best results are obtained after a soaking rain, when the ground is well saturated. Smoking should not be indulged in when carbon bisulphide is being used, as it is highly inflammable.

Calcium cyanide, when exposed to the air, gives off hydrocyanic-acid gas. The powder is placed in a small pile far down the hole with a lath or spoon attached to a stick, or better, blown into the chamber with a foot-pump dust gun. Best results are obtained in dry weather.

Gassing kills all occupants of a burrow. If an inexperienced worker cannot readily differentiate between a tenanted woodchuck burrow and that of another animal, he had best not attempt this method of destruction. Many skunks and rabbits are killed each year by those who would destroy woodchucks by the use of gas.

Trapping is considered a satisfactory means of elimination. Steel traps of a large size are commonly employed. Woodchucks have a strength far greater than that of the other small furbearers of similar size, such as the skunk, fox, and racoon. Especially in the spring are they endowed with herculean powers, and will repeatedly make their escape from heavy traps, even those equipped with double springs. The commonest method, and by far the most effective, is to place two of these traps at a single entrance.

Trapping has the disadvantage of not being selective; the jaws of steel will close about the leg of a blundering skunk as quickly as they will snap at a groundhog. Often the skunk, possibly with young, will have such a mangled foreleg that killing is the only merciful solution. I have known young boys to trap as many as five skunks in a week's time during May, in their efforts to lessen the woodchuck population.

Constant warfare is essential. A large acreage may be successfully ridden of these rodents, only to find that the same fields are again well tenanted in short order, providng that neighboring fields and pastures have not been subjected to a like drive against these animals. There are always a good supply of occupied holes in each hedgerow bordering the fields. These are usually the homes of the larger animals, which are warier and more difficult to destroy. Their offspring, or even themselves, will in time establish other home sites in the neighboring fields as the animals formerly occupying these areas are killed.

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Many papers have been consulted in the course of the present study. Some are so general in scope that they add nothing to our knowledge of the creature. This report consists of the writer's own notes on a part of the animal's life over a restricted area of its range. It does not pretend to be a monograph. In a life history study, there is generally little need to incorporate exhaustive paragraphs on the animal's range or on the various subspecies and the characters by which they are recognized. This phase of the woodchuck's history has been admirably treated by A. H. Howell (1915). For that reason the bibliography may appear short, but reference to the following papers will bring enough literature to light to cover rather thoroughly the phases of the animal's life not treated herein.

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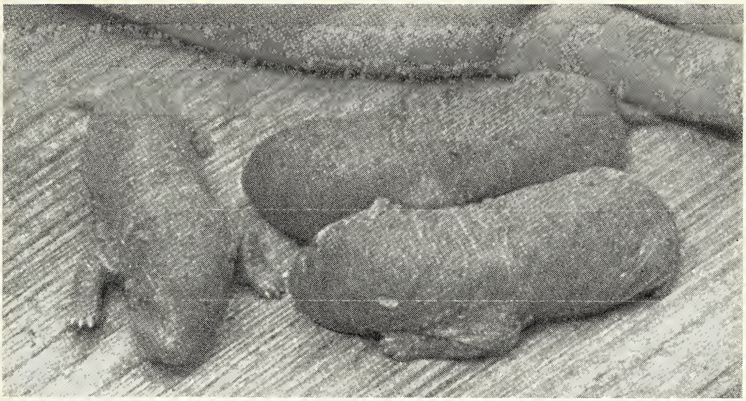
EXPLANATION OF PLATE XV.

Fig. 1. Young Woodchucks twelve hours after birth.

Fig. 2. Young Woodchucks one week old.

Fig. 3. Young Woodchucks two weeks old. Note grizzled snout.



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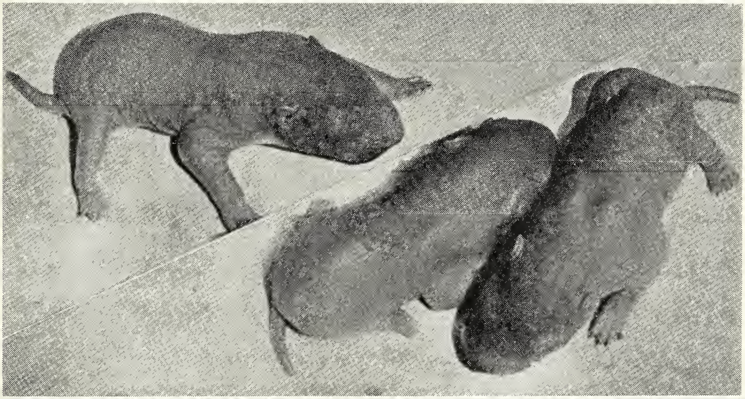

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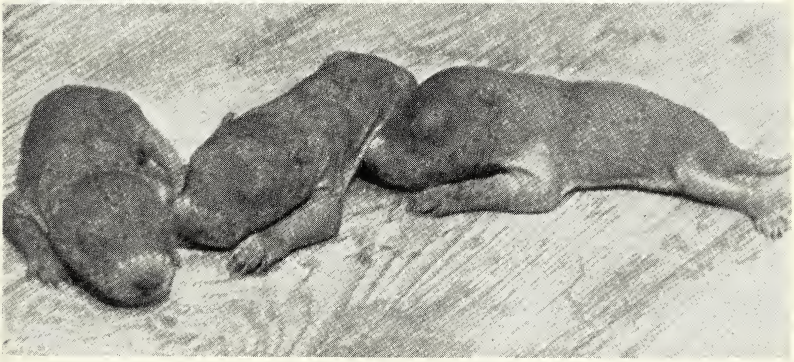

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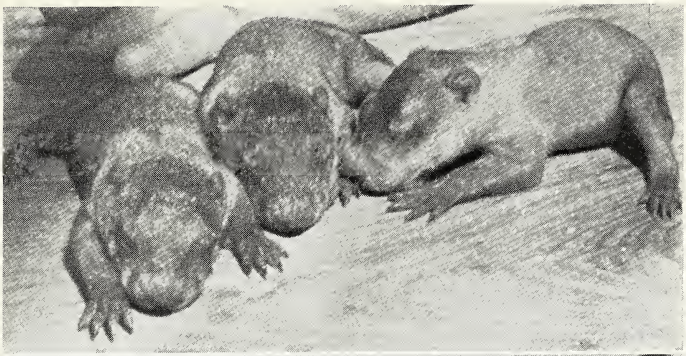
For explanation see opposite page.

EXPLANATION OF PLATE XVI.

FIG. 1. Young Woodchucks three weeks old.

FIG. 2. Young Woodchuck four weeks old.

FIG. 3. Young Woodchucks five weeks old.



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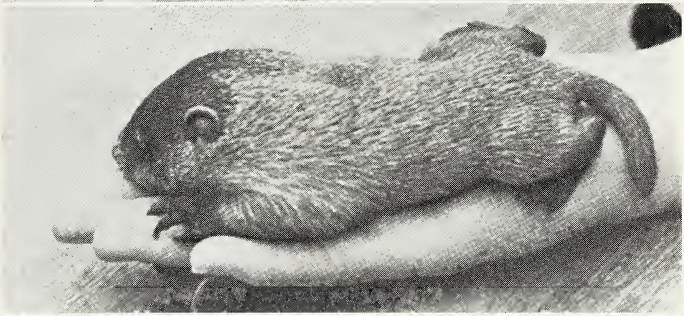

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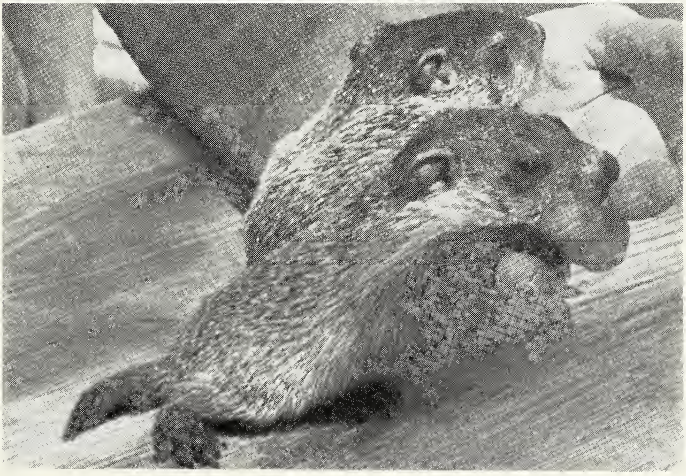

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EXPLANATION OF PLATE XVII.

FIG. 1. Young Woodchucks seven weeks old.

FIG. 2. Young Woodchucks eight weeks old.

FIG. 3. Rearing Cages for Woodchucks. The nest chamber and pipe "burrow" are covered with straw when in use.

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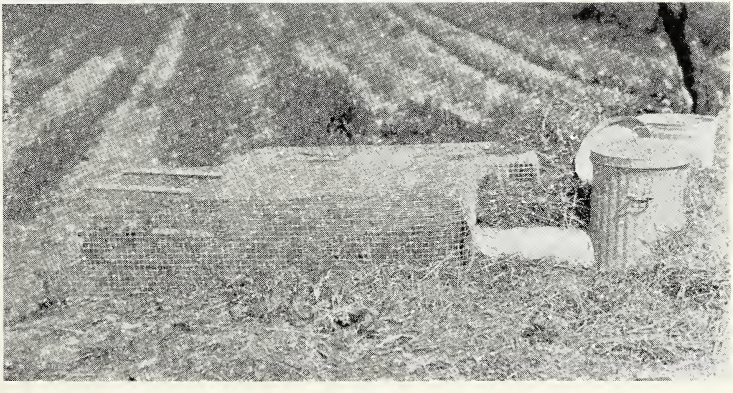

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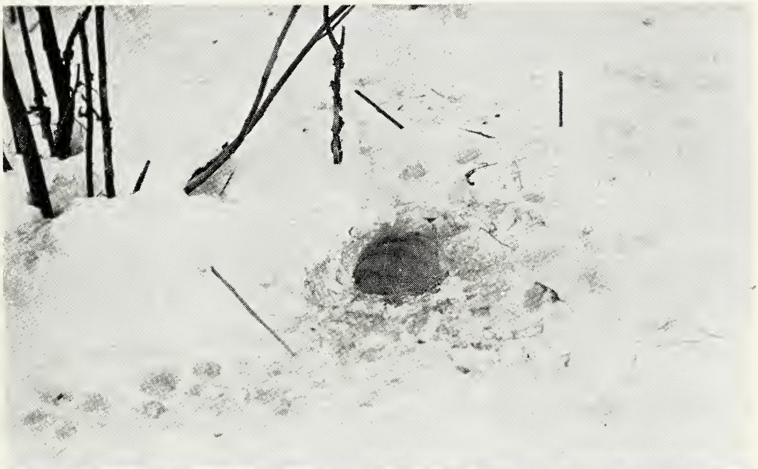
EXPLANATION OF PLATE XVIII.

FIG. 1. Tracks of running woodchuck in snow. March 27, 1932, Ithaca, New York.

FIG. 2. Woodchuck hole in snow. March 27, 1932, Ithaca, New York.

FIG. 3. Woodchuck Hole. Note step or platform used for lookout station. Such platforms are used by old individuals that have been much hunted. September 9, 1932, Ithaca, New York.

1



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EXPLANATION OF PLATE XIX.

FIG. 1. Woodchuck Habitat. The hedgerow is used as a site for hibernating dens; the meadow for rearing young and feeding.

FIG. 2. Woodchuck Habitat. The foreground is especially suitable for woodchucks, the ground being very stony and retaining heat. Because of this, early vegetation is abundant in late March and early April. The border of woods in the background is a site of several hibernating dens.

FIG. 3. Hibernating Den of Woodchuck. The top of the den is within a foot of the surface of the ground.

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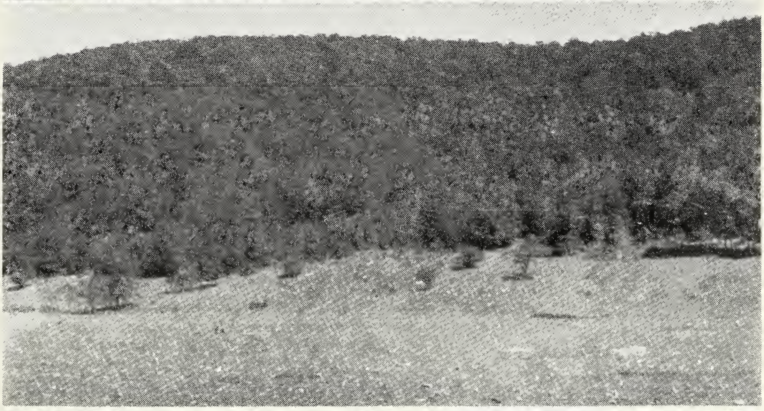

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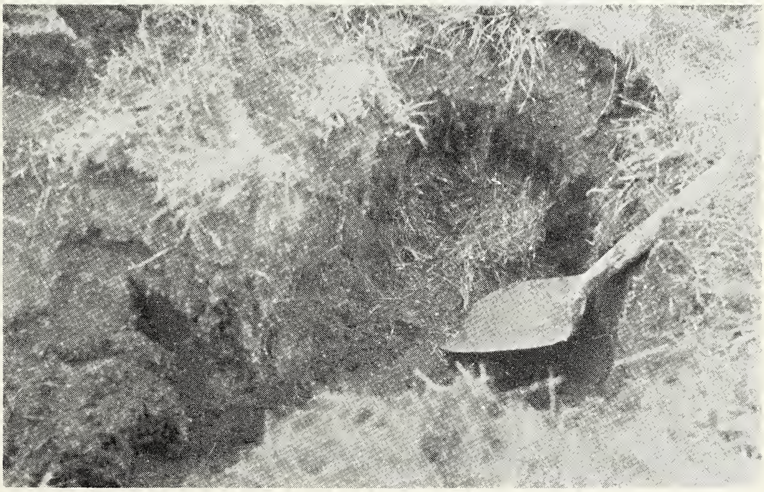

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EXPLANATION OF PLATE XX.

Fig. 1. Woodchuck with advanced malocclusion.

Fig. 2. The daily food supply (one pound of alfalfa) for a normal adult woodchuck.

Fig. 3. Mastology of lactating woodchuck. May 2, 1932, Ithaca, New York.

Fig. 4. A three hours kill of woodchucks with a rifle. The most practical way of control.

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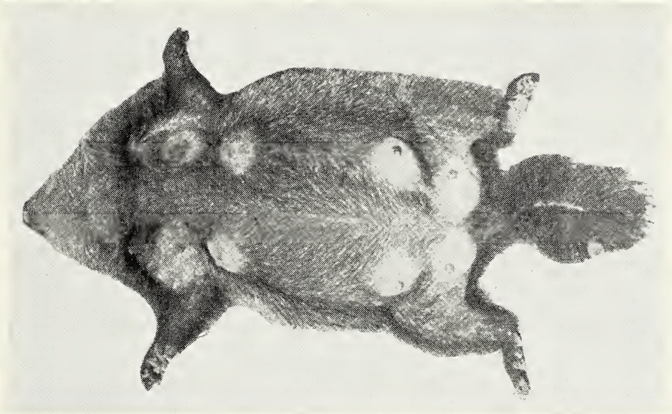

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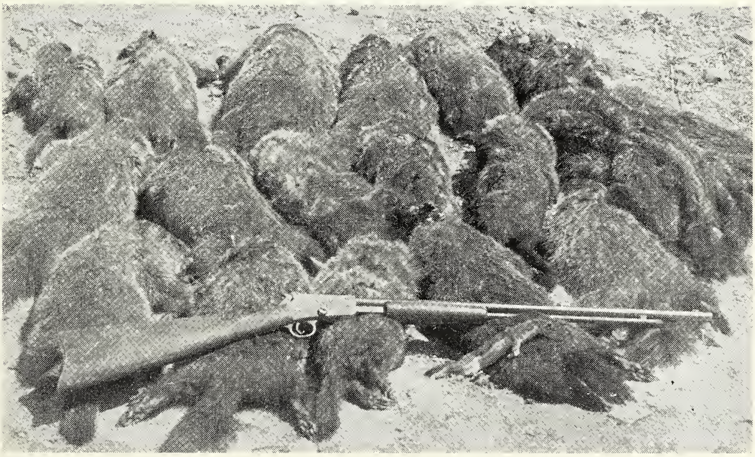

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For explanation see opposite page.

III. THE GERRINÆ OF THE WESTERN HEMISPHERE (HEMIPTERA).

By C. J. Drake and H. M. Harris, Ames, Iowa.

Water-striders form an interesting and picturesque part of aquatic life. Much attention and speculation is often aroused by the free and easy manner in which these insects live upon the surface of the water. At times they may be seen standing or resting idly, frequently drifting with the currents or under the influence of the wind. At other times they may be seen playfully jumping and skating or coursing here, there, and everywhere in search of food. When disturbed, these creatures suddenly and violently dart away from the shore by means of their long legs.

The subfamily Gerrinæ includes the largest of the American water-striders.* They are confined entirely to inland waters, and prefer the slow-moving and quiet parts of streams and sheltered places in secluded coves of ponds and lakes. In habits the species are gregarious, but they do not live in such close and compact schools as do some of the halobatoids and especially Rhagovelia-species of the family Veliidæ. For food water-striders prey largely upon other insects, frequently feeding upon forms which have by ill-luck, chance or otherwise fallen into the water and are more or less helpless. In the case of a shortage of suitable food most forms exhibit cannibalistic tendencies, the young nymphs and weaker adults often falling as victims of prey to stronger members of the same school or aggregation.

The present paper includes a brief review of family and subfamily characters, a tabular diagnosis of genera, analytic tables for the separation of species, and discriminative and distributional notes on the members of the subfamily Gerrinæ occurring in North, South and Insular America. Citations under the genera and species include references to the original descriptions, and to some of the more important nomenclatorial changes and works on biology and geographic distribution. As regards the arrangement of genera and the segregation of species an attempt has been made to indicate their natural relationship.

*Known also by the appellations water-spiders, pond-skaters, wherrymen and the like.

Issued August 1, 1934.

The thorax often shows marked differences within a species, depending on the sex and the degree of development of the wings. Because of this, efforts have been made to arrange the keys so that they apply equally well to apterous, brachypterous, and macropterous forms. Likewise the diagnostic tables will serve in identifying specimens of either sex, except in the case of that given for *Gerris* (Fabr.). In this latter genus there are groups of species in which the visible external specific differences between female specimens are so slight that they do not readily lend themselves to use in diagnostic keys, and hence the key given applies only to male individuals. For the segregation of female specimens within this genus it will be necessary to refer to the notes given in the descriptions.

Representatives of all the species discussed herein have been examined, save four species of *Potamobates*. For convenience the species have been numbered consecutively. The measurements of the antennal segments may be converted into millimeters by multiplying by .212 (1 mm. = approximately 47 divisions).

Family GERRIDÆ Amyot and Serville, 1843.

Head horizontal, shorter than pro- and mesonota united, somewhat declivent in front of eyes. Antennæ inserted in front of eyes, filiform, 4-segmented, the ring-like segment between two and three being considered as a part of the third. Rostrum short or long, 4-segmented. Body beneath densely clothed with short, appressed pile. Abdominal spiracles normal. Metasternal orifice (omphalium) median, often more or less prominent. Claws ante-apical, inserted in a cleft a little before apex of last tarsal segment. Anterior legs comparatively short, raptorial, the femora more or less incrassate. Intermediate and hind legs very long, slender. Fore coxæ considerably removed from middle pair, the middle and hind pairs placed close together.

The family Gerridæ is universally distributed. It is represented in the Western Hemisphere by two subfamilies, namely, (1) Gerrinæ Bianchi (1896) and (2) Halobatinæ Bianchi (1896). The subfamily Ptilomerinæ Esaki (1927) is confined to central and southeastern Asia and nearby islands. The subfamilies occurring in the Western Hemisphere may be differentiated thus:

Inner margin of the eyes arcuately emarginate behind the middle; body elongate, the abdomen usually long (short in a few species). Subfamily *Gerrinæ* Bianchi.

Inner margin of the eyes convexly rounded; body short, the abdomen usually nymphal-like in appearance.................Subfamily *Halobatinæ* Bianchi.

SUBFAMILY GERRINÆ Bianchi, 1896.

Small or large, usually long, sides subparallel. General color brown to black, frequently marked with brilliant silvery pubescence. Thorax modified or changed according to degree of wing-development within a species (apterous, brachypterous or macropterous). Abdomen composed of 6 visible segments (in reality 7 as the first is not discernible beneath) and two genital segments. Pterygomorphism peculiar to many species. In alate forms hemelytra somewhat coriaceous, the nervures strongly developed and prominent.

This subfamily is represented in the Western Hemisphere by five genera and fifty-five species and varieties, eleven of which are described below as new to science. *Potamobates* of Champion is the only genus restricted to the Americas.

Through the kindness of numerous friends and co-workers the writers have received many specimens of water-striders for examination and study. Thanks are especially due Dr. Hugo Kahl, Carnegie Museum; Mr. W. E. China, British Museum; Dr. H. B. Hungerford, University of Kansas; Mr. H. G. Barber, National Museum; Dr. Max Beier, Vienna Museum; Dr. Nathan Banks, Harvard University; Dr. J. C. Bradley, Cornell University; Dr. W. Rammé, Berlin. The illustrations were made by Mr. A. R. Janson and Mrs. B. V. Travis. In the descriptions and keys the writers have drawn freely upon published notes and records. The literature pertaining to several species belonging to the genera *Gerris* Fabr. and *Limnogonus* Stål is greatly involved. For many years several distinct forms were confused with some of the commoner species such as *G. marginatus* Say, *G. conformis* (Uhler), *L. hyalinus* (Fabr.), and *L. guerini* (L. & S.) and therefore often erroneously recorded in the published literature. Until quite recently two species, *G. dissortis* D. & H. and *G. notabilis* D. & H., have been confounded with the European *G. rufoscutellatus* Latr., which is not known to occur here in America.

KEY TO THE GENERA OF SUBFAMILY GERRINÆ.

I. Eyes exserted. Rostrum reaching upon anterior portion of mesosternum. Metasternum entire.......II
Eyes not exserted. Rostrum short, not reaching base of prosternum. Metasternum divided by a transverse suture so as to appear bi-segmented..IV

II. Body dull. Tarsal segments of fore leg subequal in length.......III
Body shiny. First tarsal segment of fore leg short, much shorter than second.......Genus *Limnogonus* Stål, p. 202

III. Antennæ moderately long, scarcely reaching beyond hind margin of thorax.
Genus *Gerris* Fabr., p. 182
Antennæ elongate, slenderer, practically as long as the entire body.
Genus *Tenagogonus* Stål, p. 215

IV. Very elongate, cylindrical. Middle and hind femora extending only a little beyond tip of abdomen. Male genital segments symmetrical.
Genus *Cylindrostethus* Fieb., p. 218
Body of various shapes, usually slightly flattened. Abdomen shorter, hind and middle femora extending at least one-half of their respective lengths beyond apex of abdomen. Male (and in some species female) genital segments asymmetrical..............Genus *Potamobates* Champ., p. 223

I. Genus GERRIS Fabricius, 1794

Logotype, *lacustris* (Linnæus)

Gerris Fabricius, Ent. Syst., IV, 1794, p. 187; Latreille, Consid. Genl., 1810, pp. 259, 434 (names *lacustris* type); Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 144; Bergroth, Ent. Mo. Mag., (2) XIII, 1902, p. 258-260; Distant, Fauna Brit. India, Rhyn., II, 1904, p. 176; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII 1911, p. 244; Van Duzee, Cat. Hemip., 1917, p. 426; Hungerford, Bull. Univ. Kansas, XXI, 1919, p. 108.

Aquarius Schellenberg, Geschl. Land-und Wass. Wanz., 1800, p. 25.

Hydrometra Lamarck, Syst. Anim. s. Vert., 1801, p. 295 (in part); Fabricius, Syst. Rhyng., 1803, p. 256; Mayr, Reise Freg. Novara, Zool. II, Hemip., 1868, p. 169.

Hygrotrechus Stål, Öfv. Vet. Akad. Förh., XXV, 1868, p. 395; Uhler, Stand. Nat. Hist., II, 1884, p. 267.

Limnoporus Stål, Öfv. Vet. Akad. Förh., XXVII, 1868, pp. 395, 396; Bergroth, Proc. U. S. Nat. Mus., LI, 1916, p. 237.

Limonotrechus Stål, Öfv. Vet. Akad. Förh., XXVII, 1868, p. 395.

Head short; eyes large, prominent, exserted. Antennæ moderately slender, usually reaching hind margin of pronotum. Rostrum moderately short, reaching to or a little beyond the pro-mesosternal suture. Body subparallel, clothed with short, golden hairs.

In the apterous form the pronotum usually long, its hind lobe often covering a considerable part or even all of mesonotum, or sometimes short and not produced behind. Hemelytra, when present, dark, the nervures raised and prominent. Legs variable in length in different species, sometimes extremely long; middle and posterior femora and tibiæ long; fore tarsal segments subequal in length. Body beneath covered with dense pile. Male genital segments symmetrical.

The genus *Gerris* is universally distributed, occurring on every continent. Twenty-eight species and varieties are recognized from Continental and Insular America, three of which are described below as new to science. Since *Gerris summatis*, sp. nov. is known only from female specimens it is not included in the key. Pterygopolymorphism is common, many species being represented by macropterous, brachypterous and apterous individuals. The non-shiny superior surface of head and thorax and the short golden pubescence upon upper surface of body and on nervures of hemelytra serve to separate *Gerris* from *Limnogonus*.

KEY TO SPECIES OF *Gerris* (MALES)

1. Venter simply emarginate at apex (Pl. XXIII, figs. *a, d, e, f, g*). Connexival spines very long, reaching to or slightly beyond the middle of the last genital segment (except in *chilensis* Berg)....................................2
Venter doubly emarginate behind, the second emargination forming a more or less distinct notch at the middle (Pl. XXII; Pl. XXIII, figs. *b, c*; Pl. XXIV, figs. *b, c*). Connexival spines much shorter or wanting..........8

2. Venter deeply angularly excavated behind, somewhat V-shaped (Pl. XXIII, fig. *g*)..*uhleri* D. & H., p. 186
Venter deeply roundly emarginate behind, broadly U-shaped.............3

3. Connexival spines very short, inconspicuous.........*chilensis* (Berg), p. 187
Connexival spines quite long, prominent....................................4

4. First antennal segment subequal to or distinctly longer than II and III conjoined. Color very dark..5
First antennal segment shorter than II and III conjoined. Body reddish brown or marked with reddish brown....................................6

5. First antennal segment longer than II and III conjoined. Last segment of venter without distinct median depression (Pl. XXIII, fig. *a*).
conformis (Uhler), p. 185
First antennal subequal to II and III conjoined. Last segment of venter with a prominent, deep, broad, depressed median furrow (Pl. XXIII, fig. *e*).
nebularis D. & H., p. 186

6. Smaller, 8 to 11 mm. First genital segment with median keel at base (Pl. XXIV, fig. *a*).............................*canaliculatus* Say, p. 187
Larger, 12 to 20 mm. First genital without median keel at base............7

7. Body long, with very long legs. Apex of first genital segment almost truncate (Pl. XXIII, fig. *d*)............................*notabilis* D. & H., p. 189
Shorter, with shorter legs. Apex of first genital segment slightly roundly produced (Pl. XXIII, fig. *f*)...................*dissortis* D. & H., p. 188

8. Connexiva not produced into distinct spines at apex. Segment I of antennæ not or scarcely more than three-fifths as long as II and III conjoined. Anterior femora strongly curved......................................20
Connexiva distinctly produced at apex. Segment I of antennæ as long as or almost as long as II and III conjoined. Fore femora not strongly curved..9

9. Large robust species (11 mm. or more). Connexival spines rather long and conical. First genital segment with very prominent, strongly elevated keel...10

Smaller species (less than 11 mm.). Connexival spines shorter, angular. First genital segment with keel only moderately prominent or absent........11

10. Larger, usually more or less brownish in coloration. Male genital segment as in Pl. XXIII, fig. *c*..............................*remigis* Say, p. 189

Smaller, with shorter legs and antennæ. Color deep black (Pl. XXIII, fig. *b*)......................................*nyctalis* D. & H., p. 190

11. First genital segment beneath with conspicuous, long, silvery hairs on each side...12

Genital segment without long hairs......................................13

12. Antero-lateral margins of pronotum with a more or less distinct brownish line. First genital segment with hairs arranged in rows along each side of median ridge (Pl. XXII, fig. *a*).....................*incognitus* D. & H., p. 193

Pronotum without pale stripe along side margin in front. Hairs on first genital segment forming a distinct tuft (Pl. XXII, fig. *c*).
comatus D. & H., p. 193

13. Antero-lateral margins of pronotum with a silvery or rufous stripe.........17

Antero-lateral margins without pale stripe..............................14

14. Omphalium strongly produced, very prominent........*alacris* Hussey, p. 192

Omphalium not especially prominent.....................................15

15. First genital segment plump, scarcely impressed on each side. (Pl. XXII, fig. *b*)....................................*insperatus* D. & H., p. 190

First genital segment strongly impressed on each side...................16

16. Notch at hind margin of sixth venter broadly rounded (Pl. XXII, fig. *j*).
incurvatus D. & H., p. 192

Notch at apex of sixth venter deeper, not so broadly rounded (Pl. XXII, fig. *f*)..*marginatus* Say, p. 191

17. First genital segment as broad as long, the notch in middle at apex of sixth venter subrectangular (Pl. XXII, fig. *e*)...............*buenoi* Kirk, p. 195

First genital segment distinctly longer than broad, narrowed posteriorly, median apical notch of venter rounded...............................18

18. Antero-lateral stripe of pronotum silvery. Male genital segment as in Pl. XXII, fig. *k*.............................*argenticollis* Parsh., p. 196

Antero-lateral stripe of pronotum flavous to brownish...................19

19. Connexivum above with small silvery spots between the segments. Genital segments as in Pl. XXII, fig. *h*...................*gillettei* L. & S., p. 194

Connexivum without silvery spots. Genital segment, Pl. XXII, fig. *i*.
pingreensis D. & H., p. 194

20. Metasternum and venter with distinct or fairly distinct median carina. First genital segment longer than broad. Pronotum extending on mesonotum in apterous form...21

Metasternum and venter not carinate. First genital segment short, broader than long (Pl. XXIV, fig. *c*). Pronotum in apterous form not extending back over mesonotum.....................*flavolineatus* Champ., p. 197

21. Fore femora stongly curved from the base, suddenly dilated beneath into a tubercule-like prominence. Omphalium more or less prominent.........22
Anterior femora much more flattened on basal half, without distinct tubercule-like prominence. Metasternum without stout oblong prominence......25

22. First antennal segment in length distinctly greater than width of head thru eyes. Protuberance of front femora near basal third.
carmelus D. & H., p. 201
First antennal segment in length subequal to or less than width of head thru eyes. Femoral protuberance at or beyond the middle................23

23. Fore femora with prominence at middle. Front lobe of pronotum in apterous form only moderately elevated.......................................24
Front femora with prominence at distal third. Anterior lobe of pronotum in apterous form strongly elevated.....................*beieri*, n. sp., p. 200

24. Omphalium very strongly developed, forming an oblong prominence. Genital segments, Pl. XXIV, fig. *b*..................*cariniventris* Champ., p. 197
Omphalium not especially prominent...................*kahli*, n. sp., p. 199

25. Mesonotum in apterous form covered by pronotum.
mexicanus Champ., p. 196
Pronotum of apterous form not reaching to middle of mesonotum.
fuscinervis (Berg), p. 198

1. **Gerris conformis** (Uhler) (Pl. XXIII, fig. *a*)

Hygrotrechus conformis Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 1878, p. 435.
Gerris conformis Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 271, fig. 1, *g*.

Dark brownish black; slightly longer, more robust, and with longer legs than *G. uhleri* D. & H. Antennæ dark brownish black; segment I distinctly longer than II and III taken together, II and IV subequal, III slightly shorter than II. Pronotum without pale line along sides in front; median carina quite distinct in alate form. Hemelytra brownish black. Venter dark cinereous, with small silvery spots on each side between the segments as in *uhleri*. Connexiva margined with brown, the terminal spines very long, blackish.

♂. Venter usually with median brownish line, broadly, roundly emarginate behind. First genital segment plump at the base, strongly impressed on each side behind, thus forming a median triangular keel (Pl. XXIII, fig. *a*).

♀. Very similar to *G. nebularis* D. & H. but recognizable by the longer first antennal segments and connexival spines.

Size: Length, 15.00-16.50 mm.; width, 2.70 mm.

Specimens have been examined from New York, Maryland, Pennsylvania, New Jersey, Massachusetts, District of Columbia, Virginia, North Carolina, Ohio, and Michigan.

2. **Gerris nebularis** Drake and Hottes (Pl. XXIII, fig. *e*)

Gerris nebularis Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 70; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 270, fig. 1, C.

Allied to *conformis* and *uhleri* with which it agrees in general color and markings. Antennal segment I shorter than in *conformis*. Pronotum without stripes along side margins in front. Hemelytra often abbreviated, then usually not extending beyond middle of second or third abdominal segment.

♂. Connexival spines reaching a little beyond the first genital segment. Sixth venter with a very broad, deep, median furrow, widely and roundly emarginate behind (Pl. XXIII, fig. *e*). First genital segment with a broad high keel along its entire length, the areas to each side of the keel strongly impressed.

♀. Venter with a narrow median ridge. Connexival spines slightly shorter than in *conformis*.

Size: Length, 14.00-16.00 mm.; width, 2.35 mm.

Type, male, Florida, in collection of writers. Specimens are at hand from New York, New Jersey, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Tennessee, Illinois, Ohio, Iowa, Missouri, Kansas, and Nebraska. This species is quite distinct from *conformis*, with which it was confounded in the literature for many years.

3. **Gerris uhleri** Drake and Hottes (Pl. XXIII, fig. *g*)

Gerris uhleri Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 69; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 271, fig. 1, *e*.

Elongate, moderately robust, brownish black. Antennæ brownish black, segment I slightly curved, distinctly longer than II and III conjoined, II subequal to IV and slightly longer than III. Anterior lobe of pronotum longitudinally depressed along the disc, there with a flavous line, side margins with some indications of a silvery line; posterior lobe with a rather distinct longitudinal ridge. Legs slightly shorter than in either *conformis* or *nebularis*. Venter densely clothed with silvery sericeous pile, each side with four small patches of longer, silvery hairs. Connexival spines long, reaching slightly beyond genital segments.

♂. Sixth venter deeply, sub-angularly emarginate behind (Pl. XXIII, fig. *g*); first genital segment with short, posteriorly directed, triangular keel at base.

♀. Connexival spines very long, slightly curved. Genital segments smaller and plumper than in *nebularis*, faintly impressed on the sides.

Size: Length, 14.50 mm.; width, 2.26 mm.

Known only from the type locality, Arizona (U. S. N. M.). In general appearance this species resembles *G. conformis* and *G. nebularis.* It is recognizable by the shape of the hind margin of the sixth venter and the shape and position of the keel on the first genital segment of the male. Only long winged individuals have been described.

4. **Gerris chilensis** (Berg)

Limnotrechus chilensis Berg, Ann. Soc. Cient. Argentina, XXII, 1881, p. 263.
Gerris chilensis Lethierry and Severin, Cat. Gén. Hémip., III, 1896, p. 60; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208.

Large, moderately robust, brownish black to black. Densely clothed with golden pubescence. Antennæ dark brown, segment I longer than next two conjoined, II and IV subequal, III slightly shorter than II. Anterior lobe of pronotum longitudinally depressed on the disc, there with a short flavous line along the middle. Connexiva terminating in very short spines.

♂. Sixth venter deeply and very broadly excavated behind, nearly sub-truncate at the middle. First genital segment transversely impressed at base, without keel. Connexival spines very short, much shorter than in any other of the larger forms with a single emargination at apex of venter.

♀. Connexival spines a little longer than in the male, extending to the middle of first genital segment.

Size: Length, 10.00-11.00 mm.; width, 1.50 mm.

Known from Chile, Venezuela, and Peru. Specimens from Chile (det. by Berg) have been examined. The sixth venter of the male is broadly deeply emarginate behind as in the *conformis* group.

5. **Gerris canaliculatus** Say (Pl. XXIV, fig. *a*)

Gerris canaliculatus Say, Heter. N. Harmony, 1832, p. 36; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII, 1911, p. 248; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 272.

Elongate, slender, varying from brownish black to black, sometimes reddish; testaceous beneath, with silvery reflection, the venter usually darker. Pronotum extending over mesonotum in apterous form, longitudinally carinate down the middle in both wingless and winged individuals, with a median fulvous line on front lobe; antero-lateral stripe not quite attaining the front margin. Antennæ brownish, segment I curved near base, considerably shorter than II and III conjoined; II faintly longer than III; IV subequal to I in length. Legs long, slender, brown.

♂. Connexival spines long, slender, slightly divaricating, reaching to the tip of first genital segment. Sixth venter broadly roundly excavated behind. First genital segment very broad, cylindrical; beneath with short, low, basal keel, strongly impressed before apex (Pl. XXIV, fig. *a*).

♀. Sixth venter produced behind at the middle. Connexival spines long, usually extending beyond last genital segment. First genital segment strongly compressed behind, hairy along hind margin.

Size: Length, 8.15-10.84 mm.; width, 1.00-1.25 mm.

A widely distributed lacustrine species ranging from New York to Iowa and south into Florida and Louisiana, and becoming more abundant in the southern part of its range. It is highly variable in both size and color, occasionally being quite reddish. Both apterous and macropterous forms occur in most large schools, the former tending to be darker in color. The long connexival spines and hind margin of sixth venter of male serve to separate it at a glance from the smaller members of this genus.

6. **Gerris dissortis** Drake and Harris (Pls. XXI; XXIII, fig. *f*)

Gerris rufoscutellatus Riley, Ent. Rec. and Journ. Var., XXVII, 1925, pp. 65-72, 86-93, and 109-115.

Gerris dissortis Drake and Harris, Bull. Brooklyn Ent. Soc., XXV, 1930, p. 145.

Ferrugineous to rufescent, the nervures of the hemelytra brownish black. Beneath clothed with silvery hairs. Pronotum with a very large black spot on each side of median line in front; sides with a very broad yellowish brown line; median ridge indistinct at times, paler in color. Antennæ long, reddish brown, the last segment and the tips of others darker; segment I much shorter than II and III conjoined, II and IV subequal in length, each a little longer than III. Legs very long.

♂. Genitalia very much as in *G. notabilis*, the hind margin of first genital segment slightly, roundly produced at the middle (Pl. XXIII, fig. *f*).

♀. Slightly larger than male, the legs longer. Distinguished from *notabilis* by the smaller size and the much shorter antennæ and legs.

Size: Length, 12.00-14.50 mm.; width, 1.60-2.00 mm.

Types in collection of the authors. Until recently this species has been confused in the literature with the European *G. rufoscutellatus* Latr. and *G. notabilis* D. & H. Records of *rufoscutellatus* in Eastern U. S. pertain almost entirely to this species. Specimens have been seen from Maine, Massachusetts, New York, Rhode Island, Connecticut, New Jersey, Maryland, Delaware, Pennsylvania, Michigan, Indiana, Illinois, Kentucky, West Virginia, Iowa, Missouri, Kansas, Nebraska, Wisconsin, Minnesota, and Eastern Canada. It is replaced in the West by *G. notabilis* D. & H. Only the macropterous form is known.

7. **Gerris notabilis** Drake and Hottes (Pl. XXIII, fig. *d*)

Gerris notabilis Drake and Hottes, Ohio Jour. Sci., XXV, 1925, p. 46; Drake and Harris, *ibid.*, XXVIII, 1928, p. 272, fig. 1, *d*.

Very elongate, reddish brown, the legs very long. Antennæ brown, segment IV and the tips of I, II, and III darker; I very long, considerably shorter than II and III taken together, III and IV subequal, each shorter than II. Anterior lobe of pronotum with a large black spot on each side; the space between and the side margins concolorous with rest of pronotum. Body beneath with silvery hairs.

♂. Antennæ and intermediate and posterior legs often much longer than in female. First genital almost truncate behind (Pl. XXIII, fig. *d*).

♀. Connexival spines long, slightly sinuate. Legs and antennæ much longer than in *dissortis*.

Size; Length, 15.00-20.00 mm.; width, 2.00-2.50 mm.

This is a common western species inhabiting the streams of the Pacific Coast and Rocky Mountain states, and occasionally ranging east into Iowa; frequently occurring in large schools on the surface of the mountain lakes. It has the longest body and legs of the American species of Gerrinæ. Specimens have been seen from California, Oregon, Washington, British Columbia, Idaho, Montana, Wyoming, Utah, Colorado, and Iowa. The records of *G. rufoscutellatus* Latr. from the Rocky Mountain region and Pacific slope pertain almost entirely to *notabilis*. Only the macropterous form is known.

8. **Gerris remigis** Say (Pl. XXIII, fig. *c*)

Gerris remigis Say, Heter. New Harmony, 1832, p. 35; Torre-Bueno, Ent. News, XXVIII, 1917, pp. 201-208; Riley, Ann. Ent. Soc. Amer., XIV, 1921, pp. 231-289; Essenberg, Jour. Animal Behavior, V, 1915, 397-402; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 269, fig. 1, *a*.

Gerris orba Stål, Freg. Eugen. Resa, Ins., 1859, p. 264.

Hygrotrechus robusta Uhler, Am. Jour. Sci., Ser. 3, I, 1871, p. 105.

Robust, elongate, color variable, usually brownish black, sometimes reddish brown; beneath thickly clothed with grayish pubescence. Antennæ brownish black; segment I subequal in length to II and III taken together; III subequal to II and a little shorter than IV. Connexiva with prominent silvery or golden spots at the junctions of the segments. Anterior lobe of pronotum with a broad median flavous to rufous line.

♂. Sixth venter considerably impressed, the second emargination at middle behind deeply and roundly excavated. Connexival spines moderately long. First genital segment with median keel very broad, long and prominent; very strongly impressed on each side (Pl. XXIII, fig. *c*).

♀. Connexival spines shorter than in male, extending approximately to end of genital segments.

Size: Length, 11.50-16.00 mm.; width, 3.00-4.00 mm.

This is the commonest and most widely distributed of the larger gerrids in North America. Specimens have been examined from every state in the Union, also from Canada and Mexico. It has been recorded from as far south as Guatemala. Both apterous and macropterous forms are not uncommon.

9. **Gerris nyctalis** Drake and Hottes (Pl. XXIII, fig. *b*)

Gerris nyctalis Drake and Hottes, Ohio Jour. Sci. XXV, 1925, p. 47; Drake and Harris, *ibid.*, XXVIII, 1928, p. 269, fig. 1, *b*.

Robust, blackish, sparsely pubescent, the silvery patches of connexiva much smaller than in *remigis* Say. Antennæ shorter (especially the first segment), but proportional lengths about the same as in *remigis*.

♂. Keel of first genital segment narrower than in *remigis* (Pl. XXIII, fig. *b*).

♀. Venter broader than in *remigis*. Genital segments blackish.

Size: Length 11.00-13.00 mm.; width, 2.50-3.50 mm.

Akin to *remigis* but distinguished by its darker color and shorter first antennal segment. It inhabits the Rocky Mountain regions, often occurring in abundance in lakes at high altitudes. Specimens have been seen from Idaho, Colorado, Montana, Washington, California, eastern British Columbia, and Newfoundland. Although it is usually found in the apterous form, macropterous specimens are not rare. Type, male, is in the collection of the authors.

10. **Gerris insperatus** Drake and Hottes (Pl. XXII, fig. *b*)

Gerris insperatus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 71; Blatchley, Heter. E. North Amer., 1925, p. 975; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 270.

Form, size, and markings similar to *G. marginatus*. Antennal segment I slightly shorter than II and III conjoined and about one-seventh longer than IV; II and III subequal in length. Apterous and brachypterous forms unknown.

♂. Omphalium not prominent. Venter with median carina becoming more evident apically than in *marginatus*, deeply and roundly notched in middle behind. First genital segment very short, quite plump, very faintly impressed on each side, without distinct median keel (Pl. XXII, fig. *b*).

♀. Connexiva, except outer margins, yellowish, the apical spines a little shorter and thicker than in *marginatus*. Genital segments beneath and lateral margins of first above yellowish.

Size: Length, 7.40-8.60 mm.; width, 2.30-2.50 mm.

The apical notch of sixth venter and the genital segments readily identify the male. Female specimens, however, are very difficult to separate from *marginatus* and two or three other species, the thicker connexival spines being the primary external characters. *Insperatus* ranges throughout the eastern portion of North America, from Quebec and Ontario, west to Colorado and then south into Mexico. Type, male, from Mexico, is in the U. S. National Museum.

11. **Gerris marginatus** Say (Pl. XXII, fig. *f*)

Gerris marginatus Say, Heter. N. Harmony, 1832, p. 36; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 271.

Antennæ moderately short, segment I subequal in length to II and III conjoined, and scarcely longer than IV. Pronotum without lateral stripe on anterior lobe.

♂. Venter with a deep, rounded notch in middle at apex. Genital segment I with distinct median ridge, strongly impressed on each side, clothed with fine short pile (Pl. XXII, fig. *f*).

♀. Connexival spines moderately thick, extending to apex of first genital segment.

Size: Length, 8.21-10.35 mm.; width, 2.32-2.55 mm.

The literature pertaining to this species is much involved, for until quite recently *incognitus*, *comatus*, *incurvatus*, *alacris*, *pingreensis*, *insperatus*, and perhaps one or two other distinct forms have been confused in collections, and included in scientific papers under the name *marginatus*. It is also impossible to accredit the papers on ecology and life history entirely to *marginatus* as observations, in most cases, were based on two, three or more species.

Marginatus is probably the commonest and most widely distributed member of the genus in the Americas, save perhaps *remigis*. It is known to occur in every state in the United States, and also in Canada, Mexico, and Brazil.

12. **Gerris incurvatus** Drake and Hottes (Pl. XXII, fig. *j*)

Gerris incurvatus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 72; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 270.

Form, size, and color similar to *marginatus*. Antennal segment I slightly longer than II and III conjoined, about one-third longer than IV; II scarcely longer than III.

♂. Venter with median apical notch deeper, narrower at base, and more rounded than in *marginatus*; first genital segment more strongly impressed on each side, the median keel broad at base (Pl. XXII, fig. *j*).

♀. Easily recognized by the strongly incurved connexival spines, the tips of which are clothed with short, stiff hairs.

Size: Length, 7.60-8.70 mm.; width, 2.30-2.50 mm.

Inhabits the northwestern part of the United States and adjacent territory in Canada, Washington, Oregon, California, Idaho, Montana, and British Columbia. Two examples have also been examined from the state of Illinois. In the short-winged form, heretofore unknown, the hemelytra extend slightly beyond the base of the fourth dorsum. Type, British Columbia, is in collection of the authors.

13. **Gerris alacris** Hussey (Pl. XXII, fig. *l*)

Gerris alacris Hussey, Psyche, XXVIII, 1921, p. 11, fig. 1; Blatchley, Heter. E. N. America, 1925, p. 975; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 272.

Antennæ brown, the last two segments darker; segment I subequal in length to II and III conjoined; II and III subequal, each one-third shorter than IV. Pronotum longitudinally carinate, with median brownish stripe on anterior lobe. Apterous, macropterous and brachypterous forms common; in the latter the hemelytra extend to about middle of third abdominal segment.

♂. Mesosternum with extremely large, prominent omphalium. Sixth venter with the sides of the second emargination straighter than in *marginatus*. First genital segment short, moderately impressed on each side.

♀. Connexival spines very short, their apices not attaining the middle of first genital segment.

Size: Length, 7.00-10.00 mm.; width, 2.10-2.90 mm.

Described from Michigan (types in collection of the University of Michigan) and known only from there, Hocking County, Ohio, and Washington, D. C. A very distinctive species by reason of the extremely large omphalium in the male.

14. **Gerris comatus** Drake and Hottes (Pl. XXII, figs. *c* and *d*)

Gerris comatus Drake and Hottes, Ohio Jour. Sci., XXV, 1925, p. 48; Drake and Harris, *ibid.*, XXVIII, 1928, p. 270.

Size, color, and general appearance similar to *marginatus*. Antennal segment I subequal in length to II and III conjoined; IV a little shorter than I. Apterous, short-, and long-winged forms frequently taken in the same pond or stream.

♂. With a large tuft of very long pale hairs in the impression on each side of the median ridge of first genital segment. Last venter with second emargination very similar to that in *marginatus* (Pl. XXII, fig. *c*).

♀. Connexival spines much more strongly incurved, and clothed with longer, more bristly hairs than *marginatus*.

Size: Length, 7.35-9.20 mm.; width, 2.30-2.80 mm.

Common, ranging from the Atlantic Ocean west to Montana. Specimens are at hand from New York, Iowa, South Dakota, Minnesota, Kansas, Missouri, Nebraska, Colorado, Indiana, Michigan, Pennsylvania, Ohio, Illinois, New Jersey, Maryland, and Ontario, Canada. A very distinctive species by reason of the two conspicuous tufts of long hairs on the inferior side of the first genital segment of the male. The type is in the collection of the authors.

15. **Gerris comatus mickeli** Drake and Hottes

Gerris comatus mickeli Drake and Hottes, Ohio Jour. Sci., XXV, 1925, p. 270.

This variety differs from the typical *comatus* in having a marginal stripe on each side of the anterior lobe of pronotum, and more numerous and longer hairs on the connexival spines.

Known only from brachypterous female specimens, taken in Minnesota, Colorado, and Oregon. The male is unknown. On this account it seems advisable to treat *mickeli* as a variety of *comatus* rather than as a distinct species. The type is in the collection of the writers.

16. **Gerris incognitus** Drake and Hottes (Pl. XXII, fig. *a*)

Gerris incognitus Drake and Hottes, Proc. Biol. Soc. Wash., 38, 1925, p. 73; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 270.

Antennæ reddish brown to blackish, the basal portion of segment I, the apices of I, II and III, and all of IV darker; segment I slightly shorter than II and III conjoined, II and III subequal in length, IV a little shorter than I. Pronotum with a fairly distinct longitudinal carina, the anterior lobe with a yellowish or russet-brown stripe on each side along lateral margin and also down median line. Wings often absent, when present reaching to middle of last abdominal or beyond first genital segment.

♂. Venter strongly depressed posteriorly, the three apical segments with faint, median, yellowish brown carina; deeply, widely, and roundly notched at the middle behind. Connexival spines short, blunt. First genital segment elongate; beneath strongly impressed on each side of median ridge and there with a rather dense row of long hairs (Pl. XXII, fig. *a*).

♀. Connexival spines stout, blunt, and projecting obliquely upward. First genital segment narrowed posteriorly, truncate at apex. Wingless form with a large tumid area above at base of abdomen.

Size: Length, 8.50-9.50 mm.; width, 2.50-2.90 mm.

Common in western United States. Known from Washington, Oregon, California, Montana, and Idaho. Specimens have also been examined from British Columbia and Quebec. The holotype (male) and allotype (female) from Kaslo, B.C., are in the U. S. National Museum.

17. **Gerris pingreensis** Drake and Hottes (Pl. XXII, fig. *i*)

Gerris pingreensis Drake and Hottes, Ohio Jour. Sci., XXV, 1925, p. 49; Drake and Harris, *ibid.*, XXVIII, 1928, p. 272.

Resembles *gillettei* in form, size, and color, but distinguishable by the more tumid first abdominal tergite and the lack of silvery spots between the segments of connexivum. Antennæ moderately short; segments I and IV subequal in length, II much shorter, a little longer than III.

♂. Venter darker, the longitudinal sulci on sixth segment deeper, and the median apical notch slightly broader at base than in *gillettei* (Pl. XXII, fig. *i*).

♀. Connexival spines very much longer than in male, shorter than in *gillettei*, in apterous individuals reflexed, almost vertical.

Size: Length, 9:00-10:00 mm.; width, 2.00-2.50 mm.

Found in abundance in the streams and lakes of the higher altitudes of Montana, Colorado, and Idaho and of Alberta, Canada. A very distinct species by reason of the male genitalia and the connexival spines in both sexes.

18. **Gerris gillettei** Lethierry and Severin (Pl. XXII, figs. *g* and *h*)

Limnotrechus productus Uhler, Hemip. Colo., 1895, p. 61.

Gerris gillettei Lethierry and Severin, Cat. Génl. Hémip., III, 1896, p. 60; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 272.

Larger and more robust than *marginatus*. Antennæ with segment I shorter than II and III conjoined and about one-fifth longer than IV, II and III subequal. Pronotum with a russet-brown stripe along antero-lateral margins. Wings absent or reaching to middle of genital segments. Apterous form with bases of thorax and abdomen above somewhat tumid; connexival spines shorter than in macropterous form.

♂. Venter yellowish testaceous apically, the sixth segment distinctly flattened and with a long conspicuous sulcus on each side of the narrow median ridge, the second emargination as in Pl. XXII, fig. *h*. First genital segment rather plump, faintly impressed on each side, without noticeable vestiture.

♀. Abdomen somewhat flattened beneath. Genital segment strongly compressed laterally. Connexival processes long, curved inwards and upwards, considerably longer in macropterous than in brachypterous form (Pl. XXII, fig. *g*).

Size: Length, 8:60-10:50 mm.; width, 1.70-2.30 mm.

This is a western species. Specimens have been seen from Washington, Oregon, California, Montana, Utah, Colorado, and Texas. It may be recognized by the presence of conspicuous silvery spots at the outer angles of the connexival segments. The type of *productus* is in the collection of Colorado Agricultural College.

19. **Gerris buenoi** Kirkaldy (Pl. XXII, fig. *e*)

Gerris buenoi Kirkaldy, Ent. News, XXII, 1911, p. 246; Torre-Bueno, Trans. Amer. Ent. Soc., XXXVII, 1911, p. 248; Parshley, Ent. News, XXVII, 1916, pp. 103, 104, fig. *c*; Hoffman, Ann. Ent. Soc. Amer., XVII, 1924, pp. 424-426; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 272.

Short, robust. Antennal segment I shorter than II and III conjoined, one-fifth longer than IV; III scarcely shorter than II. Pronotum with median and antero-lateral stripes flavescent to russet-brown in color. Venter with indistinct median keel.

♂. Sixth venter with median notch very broad and deep. First genital segment very broad, transversely impressed beneath (Pl. XXII, fig. *e*).

♀. Connexival spines short. Genital plates beneath very broad, somewhat flattened.

Size; Length, 7.00-8.21 mm.; width, 1.31-1.60 mm.

A transcontinental species ranging throughout the northern part of the United States and southern Canada. Readily recognized by its size, form, and genital structures. Apterous, half-winged and fully winged specimens frequently are taken in the same school. The type is in the Kirkaldy collection, U. S. National Museum.

20. **Gerris argenticollis** Parshley (Pl. XXII, fig. *k*)

Gerris argenticollis Parshley, Ent. News, XXVII, 1916, p. 103, fig. *a*; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 272.

Moderately large. Pronotum with median and antero-lateral stripes yellowish, the latter clothed with silvery pubescence. Antennal segments II and III subequal in length, each about half as long as I and one-fifth longer than IV. Hemelytra whitish between the nervures along the inner margins at the base. Venter with distinct median carina.

♂. Sixth venter with median apical notch much narrower and more rounded than in *buenoi*. First genital segment also narrower and not so strongly produced beneath at apex, feebly impressed behind on each side of narrow median ridge (Pl. XXII, fig. *k*).

♀. Connexival spines short, stout. First genital segment slightly wider than long, carinate toward the base and strongly impressed on each side before the middle.

Size: Length, 7.00-8.50 mm.; width, 1.62-1.80 mm.

Type, from Massachusetts, in Parshley collection. Ranges from Massachusetts west through Indiana and Illinois and south into North Carolina and Louisiana. Related to *G. buenoi* and replacing it to some extent in the southern part of the United States.

21. **Gerris mexicanus** Champion

Gerris mexicanus Champion, Biol. Centr. Amer., Rhynch., II, 1898, p. 147, Pl. IX, fig. 10; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209.

Winged form: Rather elongate, robust; brownish black to black, markings on head and median line on front of pronotum ochraceous, the hind lobe of pronotum largely brownish testaceous or reddish brown. Antennæ rather stout, segment I about one-half longer than II, II-IV subequal in length. Anterior femora stout. Hind tarsi with segment I two and one-half times as long as II. Hemelytra extending beyond tip of abdomen. Connexiva not produced apically.

Apterous form: Pronotum covering mesonotum, the anterior lobe slightly raised and rather sharply demarcated; hind lobe reddish brown.

♂. Anterior femora curved from the base, concave and flattened on basal half beneath, distinctly dilated towards the apex on the lower side. Sixth venter deeply emarginate behind, the median notch rather broad. First genital short and plump beneath, without keel.

♀. More robust than male. Venter subtruncate behind, the last segment not quite as long as the preceding.

Size: Length, 8.50-12.00 mm.; width, 2.80-3.50 mm.

Known only from Mexico. Two females and a male specimen have been studied. Although a little smaller, this species has somewhat the general facies of *G. remigis* but is easily distinguishable from it by the characters given above and in the key.

22. **Gerris flavolineatus** Champion (Pl. XXIV, fig. *c*)

Gerris flavolineatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 149, Pl. IX, figs. 13-15; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209.

Winged form: Broad, robust, male much smaller and narrower than female; above brownish black to black, a curved band at base of head and a narrow longitudinal vitta on disc of pronotum ochraceous; sides of head before the eyes, and sides of both anterior and posterior lobes of pronotum reddish brown. A spot on middle and posterior acetabula, and a broad line on sides of mesothorax silvery. Body beneath somewhat silvery. Sides of thorax largely black, sometimes lighter. Anterior femora brownish, with a broad blackish longitudinal stripe without; tibiæ straight, blackish; tarsi black. Antennæ with segments II to IV subequal, I about one-third longer than II.

Apterous form: Pronotum short, not produced over mesonotum, the latter variable in color, usually more or less ochraceous.

♂. Anterior femora stout, strongly curved at base, hollowed beneath. Sixth venter not quite as long as the two preceding segments, subangularly emarginate in the middle behind. Connexiva not produced behind. First genital segment plump, emarginate at apex (Pl. XXIV, fig. *c*).

♀. Anterior femora thinner and only feebly curved at base.

Size: Length, 5.20-10.00 mm.; width, 2.00-3.50 mm.

Type in the British Museum; paratypes have been examined, also a long series of apterous and winged specimens from Guatemala. Known from Mexico, Guatemala, and Ecuador.

23. **Gerris cariniventris** Champion (Pl. XXIV, fig. *b*)

Gerris cariniventris Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 148, Pl. IX, figs. 11-12; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208.

Winged form: Black, a median line on front lobe of pronotum, the lateral margins and sometimes hind margins of pronotum, pleura in greater part, markings on head, the coxæ, and margins of connexiva ochraceous; body beneath lighter. Antennæ rather slender, segments II-IV subequal in length, I about one-fourth longer than II. Anterior lobe of pronotum short, rather sharply demarcated; posterior lobe rounded behind, transversely raised between the tumid humeri, more or less distinctly carinate down the middle. Sides of thorax with prominent silvery markings.

Apterous form: Pronotum produced backwards and extending about to middle of mesonotum, rounded behind; mesonotum ochraceous to reddish brown, sometimes marked with a small blackish patch in front.

♂. Anterior femora stout, curved at base, subangularly dilated on the inferior surface, forming a distinct protuberance at the middle; tibiæ slightly curved. Omphalium very prominent. Venter carinate down the middle, the sixth segment much longer than the preceding, the second emargination at middle behind deep and rounded (Pl. XXIV, fig. *b*). Connexiva not terminating in spines.

♀. Much larger and stouter than male. Anterior femora feebly curved at base, without prominence. Metasternum carinate. Connexiva not strongly narrowed posteriorly, truncate at apex.

Size: Length, 7.50-10.50 mm.; width, 2.30-3.20 mm.

Type in British Museum; paratypes have been examined. Recorded in the literature from Mexico, Guatemala, Costa Rica, Panama, and Hayti. A long series of apterous and winged specimens are at hand from Guatemala and British Honduras.

24. **Gerris fuscinervis** (Berg)

Brachymetra fuscinervis Berg, Com. Mus. Buenos Aires, I, 1898, p. 3; Pennington, List Hemip. Heterop., Repub. Argentina, 1921, p. 31.

Gerris perseus Kirkaldy, Bull. Mus. Zool. Anat. Comp. Torino, XIV, 1899, No. 351, p. 1.

Gerris andromeda Kirkaldy, Bull. Mus. Zool. Anat. Comp. Torino, XIV, 1899, No. 351, p. 2, figs. 8, 9.

Gerris fuscinervis Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 208.

Apterous form: Moderately large, brownish black to black. Antennæ blackish; proportions—(male) 60:36:36:42, (female) 75:40:38:45. Posterior lobe of pronotum covering about half of mesonotum, broadly rounded behind; anterior lobe with median longitudinal stripe and a narrow stripe on each side ochraceous. Sides of thorax blackish, becoming darker above, with a prominent silvery streak on the meso- and metapleura. Body beneath yellowish brown with grayish pubescence. Mesosternum channeled anteriorly. Sides of abdomen blackish.

♂. Sixth venter subequal in length to the preceding two segments conjoined, with a deep, very broad, rounded notch at the middle behind. First genital segment plump beneath, moderately narrowed distally. Front lobe of pronotum (apterous form) quite strongly raised, depressed on disc; posterior lobe reaching to middle of mesonotum. Mesonotum tumid behind, mostly ochraceous. Connexiva narrowed posteriorly, truncate behind. Anterior femora short, stout, very strongly curved at the base, there hollowed beneath.

♀. Larger and broader than male. Anterior lobe of pronotum impressed, with a prominent tubercule on each side in front; hind lobe (apterous form) broader and a little longer than in male. Connexiva broader behind than in male, truncate at apex. Sixth venter in length subequal to the preceding two segments, clothed with long hairs on the hind margin.

Size: Length, 6.30-8.50 mm.; width, 2.00-3.10 mm.

Recorded in the literature from Ecuador, Bolivia, and Argentina. Specimens labelled "*cum type comparat*" by Berg in the U. S. National Museum have been studied, also numerous examples from Cordoba, Argentina. Type is in the La Plata Museum, Argentina.

25. **Gerris kahli,** sp. nov.

Apterous form: Blackish, a median line on anterior lobe of pronotum, mesonotum, sides and body beneath reddish brown. Antennæ dark brown; proportions—(male) 55:46:60:54, (female) 62:60:70:58. Pronotum of male with anterior lobe more tumid and slightly more impressed on the disc than in female; antero-lateral angles raised and prominent in female; posterior lobe broadly rounded behind, extending over anterior half of mesonotum, transversely rugose. Mesonotum tumid and prominent.

Winged form; Pronotum very large, black, with golden pubescence, tumid behind, the humeri prominent; anterior lobe impressed on the disc, there with a short median stripe. Hemelytra black. Body a little longer and slenderer than in apterous form.

♂. Anterior femora strongly curved at base, strongly dilated at the middle beneath, there forming a tubercle-like prominence, this and end of trochanter densely set with brownish black hairs. Fore tibiæ slightly curved. Omphalium fairly prominent. Venter with basal two segments carinate, last segment as long as the two preceding, and deeply, broadly, roundly notched in middle at apex. First genital segment long, cylindrical. Connexiva moderately broad, sometimes with brown markings, strongly narrowed posteriorly, not produced at apex.

♀. Much larger and stouter than male, with silvery stripe along the sides of thorax extending over acetabula. Connexiva broader than in male, not so strongly narrowed posteriorly. Venter with hind margin truncate, and strongly ciliate. Metanotum (apterous form) not raised on each side as in male.

Size: Length, 8.10-9.41 mm.; width, 1.62-2.42 mm.

Holotype, apterous male, and *allotype*, apterous female, Elvecia, near Mt. Turumquire, Sucre, Venezuela, collected by Mr. G. Netting; in collection of Carnegie Museum. *Paratypes*, numerous apterous and winged specimens taken with type. This insect is named in honor of Dr. Hugo Kahl, Curator of insects at Carnegie Museum, who is keenly interested in the insect fauna of the Americas. In general appearance and markings similar to *G. cariniventris* Champ. and *G. carmelus* D. & H. The protuberance on the inferior surface of the fore femora of the male together with the antennæ and omphalium serve as discriminative structures.

26. **Gerris beieri,** sp. nov.

Apterous form: Akin to *G. cariniventris* Champ., but recognizable by the structure of the pronotum, the proportional lengths of antennal segments, and the position of the protuberance on fore femora of male. Head blackish above, reddish brown on the sides and base. Antennæ brownish, the last two segments darker; proportions—(male) 75:53:55:50, (female) 105:76:75:63. Rostrum reaching upon the anterior portion of mesosternum, the apical segment blackish. Pronotum with the sides and a median streak reddish brown, slightly depressed on the disc; posterior lobe black, transversely rugose, rounded behind, projecting over three-fourths of mesonotum. Mesonotum reddish brown, sometimes blackish along the sides. Metanotum and abdomen above black. Body beneath yellowish brown. Middle and hind acetabula blackish above.

♂. Anterior lobe of pronotum very strongly raised, tumid; hind lobe much narrower than in female. Connexiva slightly embrowned along the margins, not produced apically. Front femora very broadly and strongly curved at base, paler and hollowed beneath, the protuberance darkened, placed a little before the apex; tibiæ slightly curved, darkened distally. Sixth venter considerably longer than the preceding, the second emargination shallow and rounded. First genital segment beneath plump, subtruncate at apex.

♀. Very much broader and stouter than male. Fore femora slightly curved, without armature. Front lobe of pronotum faintly raised, strongly impressed on the disc, there with a median flavous line; posterior lobe very much broader than in male. The silvery spot on middle and hind acetabula, and the darkened streaks on mesopleura more prominent than in male. Connexiva margined with brown, not produced behind. Sixth venter about two-thirds as long as the preceding segment.

Size: Length, 8.00-10.50 mm.; width, 1.60-2.50 mm.

Holotype, apterous male, and *allotype*, apterous female, Colombia, South America (Thorey); in Vienna Museum. *Paratypes*, two males and four females taken with type. Named in honor of Dr. Max Beier, of the Vienna Museum, who is taking a keen and active interest in South American insects.

27. **Gerris carmelus** Drake and Harris (Pl. XXV, fig. *d*)

Gerris carmelus Drake and Harris, Psyche, XXXIX, 1933, p.108.

Head black, its sides and inferior surface and a transverse patch above at the base ochraceous, sometimes these markings more or less replaced with black. Antennæ brown, darkened apically; segment I a little longer than II, II and III subequal, each slightly longer than IV. Rostrum ochraceous, the distal segment black, extending on anterior portion of mesosternum. Pronotum black, the sides and a median elongate spot on disc of anterior lobe ochraceous; hind lobe attaining middle of mesonotum, rounded behind. Mesonotum ochraceous, strongly raised, tumid, almost rectangular in outline. Sides of thorax ochraceous, the meso- and metapleura with a longitudinal blackish stripe, this at times extending on propleuron.

♂. Anterior lobe of pronotum strongly raised, sharply delimited. Front femora moderately incrassate, curved at base, the inferior surface a little behind the middle strongly dilated into a prominent blackish tubercle. Venter indistinctly carinate along median line; sixth segment about as long as the preceding two, its apical margin deeply and roundly excavated at the middle behind. First genital segment long, sub-cylindrical.

♀. Broader than male. Anterior lobe of pronotum feebly raised. Metanotum with a prominent, raised callosity on each side, these pale and conspicuously hairy. Connexiva broader than in male, clothed along apical half with brownish hairs, these becoming longer and more numerous distally; apices strongly produced into very long, upwardly curving, hairy processes (Pl. XXV, fig. *d*). Mesosternum and venter carinate down the middle. Sixth segment without carina, more thickly pilose and slightly more than twice as long as the preceding.

Size: Length, 7.00-8.50 mm.; width, 2.00-2.60 mm.

Known only from the type locality, Jamaica. Type in collection of Harvard University. This species is probably most closely related to *G. cariniventris* Champ. and *G. kahli*, sp. nov. It may be recognized by the nature of the front legs and genital segments of the male, and by the very long flattened, connexival processes of the female, which are about two-thirds as long as the segment from which they arise. The color markings are somewhat variable.

28. **Gerris summatis,** sp. nov.

Apterous form: Antennæ brownish; proportions, 62:53:57:58. Head black, the sides in front of eyes, a narrow longitudinal stripe on each side above, and the basal margin reddish brown. Pronotum black, most of the sides of anterior lobe, and an elongate median spot on disc reddish brown; hind lobe sharply rounded posteriorly, not quite reaching the middle of mesonotum. Mesonotum largely reddish brown, strongly tumid posteriorly, there terminating in a point. Mesopleura reddish brown, with a prominent silvery stripe. Abdomen blackish, with a more or less distinct median stripe, connexivum broadly margined with brown, not terminating in a spine behind. Rostrum reaching upon anterior portion of mesosternum, the last segment black. Mesosternum tumid, shallowly channeled anteriorly. Legs brown, the tarsi darker. Metasternum and venter yellowish, carinate down the middle; venter roundly produced behind.

Winged form: Anterior lobe of pronotum scarcely raised, impressed on the disc, a broad stripe on each side and a short median stripe on disc, yellowish brown; posterior lobe with a median carina, the humeri prominent. Wings blackish.

Size: Length, 6.91-8.03 mm.; width, 2.10 mm.

Holotype, apterous female, Rio Sarapiqui, Costa Rica, altitude 2000 meters, collected by Heinrich Schmidt; University of Kansas. *Paratypes*, 1 apterous and 1 winged female, taken with type. The proportional lengths of the antennal segments and the peculiar structure of the mesonotum separate this species from its allies.

II. Genus Limnogonus Stål, 1868

Logotype, *hyalinus* Fabr.

Limnogonus Stål, Hemip. Fabr., I, 1868, p. 132; Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 151; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210.

Lamprotrechus Reuter, Öfv. Finska Vet. Soc. Förh., XXV, 1882, p. 40.

Tenagogonus Van Duzee, Cat. Hemip., 1917, p. 429 (in part); Anderson, Univ. Kansas, Sci. Bul., XX, 1932, p. 298.

Body short to moderately elongate, the abdomen somewhat abbreviated in certain species, long in others; head and pronotum glabrous, shiny. Antennæ shorter than body, the basal segment longest. Anterior tarsi with first segment short, only about half as long as second. Middle and hind legs very long, the femora extending far beyond the tip of abdomen.

The short basal tarsal segment of fore legs, shorter and stouter antennæ, and the shiny surface of the head and pronotum are the chief characters separating *Limnogonus* from *Tenagogonus* and *Gerris*.

Thirteen species, including six new forms, are recognized from within our limits. The writers have seen specimens of only two of these from north of the Mexican boundary. *Limnogonus franciscanus* Stål, from California, is not treated separately in this paper because of the lack of determined specimens. The species has not been recognized since its description in 1859. It is perhaps conspecific with *guerini* (L. & S.), but the type will have to be examined before it can be identified with any degree of certainty.

It should be noted that in some species female specimens are as yet unknown. Also in certain species both alate and apterous forms have not been described for both sexes. As a consequence of the great structural differences between these forms within a species, it has been impossible to construct a complete key. The table given below, however, will serve to identify all the forms now known.

KEY TO SPECIES OF *Limnogonus*

1. Pale markings on margins of pronotum continued anteriorly along the sides of the front lobe and extending to its front margin* (If interrupted or obsolete along side margins of front lobe then the length of antennal I is greater than width of head thru eyes) 10
   Side margins of anterior lobe of pronotum without evidence of pale lines. Length of antennal I usually less than width of head thru eyes, sometimes subequal 2
2. Apterous 3
   Macropterous (*celeris*, *genticus*, and *visendus*, unknown in winged form) 8
3. Pronotum produced posteriorly, distinctly longer than broad, differentiated into two lobes 5
   Pronotum short, broader than long, without evidence of hind lobe 4
4. Length of first antennal segment subequal to width of head thru eyes. Apex of abdomen not surpassing basal one-fifth of hind femora.
   hesione (Kirk.), p. 211
   Length of first antennal scarcely greater than width of vertex plus one eye. Abdomen much longer, extending to basal one-third of hind femora.
   visendus, sp. nov., p. 215
5. Pronotum reaching to metanotum, almost or completely covering mesonotum 6
   Pronotum reaching to middle of mesonotum 7
6. First genital segment above narrow, tapering posteriorly, the apical margin not or scarcely notched at middle . . . . *lubricus* White, p. 212
   First genital segment above very broad, the sides almost parallel, the hind margin deeply notched at the middle (Pl. XXV, fig. *a*)
   celeris, sp. nov., p. 214
7. Larger, (male) 5.6 mm., (female) 6.7 mm. Eyes as seen from the side almost spherical, not longer than deep . . . . *lotus* White, p. 213
   Smaller, (male) 4.15 mm. Eyes as seen from the side flattened, plainly longer than deep . . . . *genticus*, sp. nov., p. 213

*In some specimens the pale markings are reduced to a small spot behind each eye.

8. Eyes globose, not longer than deep. Pronotum strongly constricted at the sides between the two lobes. Front femora with an oval blackish spot on the outer (posterior) surface before apical third......*lotus* White, p. 213
Eyes longer than deep. Pronotum less strongly constricted at the sides. Front femora almost entirely blackish along distal half of posterior surface ..9

9. Antennal segments I and II, except apices, brownish.
lubricus White, p. 212
Antennal segments I and II entirely fuscous to black. Male genital segments as in Pl. XXIV, fig. *d*..........................*hesione* (Kirk.), p. 211

10. Antennal segment I less than width of head thru eyes. Mesopleura broadly marked with reddish or russet brown along the upper sides.
ignotus, sp. nov., p. 205
Antennal segment I equal to or greater than width of head thru eyes. Mesopleura above next to pronotal margins brown to black, sometimes interrupted with yellowish or silvery..11

11. Male..12
Female..17

12. First genital segment beneath produced at apex.......................14
First genital segment beneath not produced at apex....................13

13. Metasternum distinctly swollen. First genital segment beneath slightly impressed on each side..........................*guerini* (L. & S.), p. 206
Metasternum flat, not swollen. First genital segment beneath distinctly constricted across the middle, broader than distance between apices of connexiva.................................*profugus* D. & H., p. 209

14. First genital segment beneath with a tumid, almost hemispherical gibbosity, the apex produced at the middle into a prominent recurved spine (Pl. XXIV, fig. *k*)...............................*recurvus* D. & H., p. 210
First genital segment not as above....................................15

15. First genital segment beneath raised into an enormous keel, this greatly produced so that it extends as far posteriorly as does the dorsal part of the segment (Pl. XXV, fig. *b*)......................*hyalinus* (Fabr.), p. 208
First genital segment not as above....................................16

16. Apex of first genital segment beneath produced at the middle into a short obliquely projecting point (Pl. XXV, fig. *c*). Mesosternum plump.
recens, sp. nov., p. 207
Apex of first genital segment beneath produced into a short, recurved tooth. Mesosternum broadly, shallowly impressed........*aduncus* D. & H., p. 209

17. Connexivum truncate at apex, not produced beyond corresponding abdominal tergite.................................*hyalinus* (Fabr.), p. 208
Connexivum more or less produced at apex, extending beyond last abdominal tergite...18

18. Last segment of venter rather sharply produced at the middle behind. Connexival spines moderately long (Pl. XXIV, fig. *l*)..*aduncus* D. & H., p. 209
Last segment of venter more broadly rounded behind. Connexivum not so strongly produced apically...19

19. Upper portion of mesopleura largely reddish brown, this not divided by a paler longitudinal stripe. Genital segments as in Pl. XXIV, fig. *j.*
recurvus D. & H., p. 210

Upper portion of mesopleura black, this divided by a more or less broad yellowish to silvery stripe...20

20. Last venter more strongly produced, the central portion extending slightly farther posteriorly than the connexival processes. The yellowish brown stripe of mesopleura expanded, arched above, broader than the black.
profugus, D. & H., p. 209

Last segment of venter only slightly produced behind. Yellowish brown stripe of mesopleura narrower, its sides practically parallel............21

21. Connexivum above with a broad, uninterrupted longitudinal yellowish brown stripe...*guerini* (L. & S.), p. 206

Connexivum above with three to five large silvery to yellowish brown spots, these sometimes more or less connected............*recens*, sp. nov., p. 207

1. **Limnogonus ignotus,** sp. nov.

Winged form: Form, size and facies very similar to *L. guerini*; coloration also quite similar but differing in having a broad, reddish brown stripe along the entire length of the upper margin of each side of thorax. Pronotum black, shiny, the anterior lobe depressed on the disc, with a very short brownish stripe on each side of median line, and only slight indications of median carina, the antero-lateral margins with a flavous stripe; posterior lobe margined with flavous. Head with a broad longitudinal yellowish stripe on each side between the eyes, sometimes each of these divided by a narrow blackish line. Rostrum reaching upon mesosternum, black at apex. Antennæ brown, the last two segments darker; proportions—(male) 70:41:41:65, (female) 75:50:48:73. Hemelytra brownish black, the nervures raised and prominent. Anterior femora faintly curved, slightly incrassate, paler at the base. Middle and hind legs dark brownish black. Body beneath whitish testaceous, the venter sometimes embrowned; sides of mesopleura largely black, the upper margin of sides of entire thorax broadly margined with reddish brown; venter with a black stripe on each side.

♂. Sixth venter very broadly, deeply, roundly emarginate behind at the middle, a little longer than the preceding segment. First genital segment large, slightly impressed on each side near the middle, the apical margin subtruncate. Connexiva terminating in very short, triangular processes.

♀. Sixth venter about twice as long as the preceding segment, the apical margin deeply, roundly, broadly emarginate on each side, thus leaving the middle faintly produced. Connexiva terminating in acute black spines. First genital segment impressed on each side.

Size: Length, 6.50-9.40 mm.; width, 1.40-1.80 mm.

Holotype, winged male, and *allotype*, winged female, Villa Rica, Paraguay, S. A., February 21, 1923, collected by F. Schade; in collection of the University of Kansas. *Paratypes*, males and females, taken with types; also from Santa Cruz, Bolivia, J. Steinbach; British Guiana, near New Amsterdam, F. X. Williams; Nalique, Matto Grossa, Brazil, Manizer; Missiones, Loreto, Argentina, A. Ogloblin; in collections of University of Kansas, Petrograd Museum and the writers. In the apterous female the pronotum covers the mesonotum, and the connexiva are broad and have a broad submarginal flavous line.

Very common and widely distributed in South America. Although closely allied to *L. guerini* (L. & S.), it is easily recognizable by the broad reddish brown stripe along upper margins of sides of thorax, the longer, more acute connexival spines in the female, and the slightly differently formed genital segments in the male. The broad stripe along each side of the thorax is fairly prominent.

2. **Limnogonus guerini** (Lethierry & Severin) (Pl. XXIV, fig. *e*)

Gerris marginatus Guérin, Icon. Regne Anim., Ins., 1844, p. 351, Pl. 57, fig. 2; Guérin, *in* Ramon de la Sagra's Hist. fis., polit. y nat. de Cuba, Ins., 1857, p. 415.
Limnometra marginata Uhler, Proc. Zool. Soc. Lond., 1893, p. 706; 1894, p. 212.
Gerris guerini, Lethierry and Severin, Cat. Gén. Hémip., III, 1896, p. 61.
Limnogonus marginatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 152.
Limnogonus guerini Kirkaldy & Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Drake and Harris, Psyche, XXXIX, 1933, p. 109.

Form, color and markings very similar to *L. hyalinus* Fabr. Size very variable. Antennæ and legs considerably longer in the larger specimens, but the relative proportions of antennal segments remain approximately the same; antennal formula—(small individuals) 65:46:45:60, (large specimens) 95:62:55:72. Rostrum shorter than in *hyalinus*.

♂. Genitalia as in Pl. XXIV, fig. *e*. Connexivum moderately narrow, slightly produced at apex.

♀. Connexiva broader than in male, angulate and slightly more produced at apex.

Apterous form: Smaller than the winged form, the posterior lobe of pronotum a little narrower and more sharply rounded at apex than in *recens*.

Size: Length, 5.00-8.71 mm.; width, .90-1.80 mm.

The commonest and most widely disseminated member of the genus in the West Indies, Central America, and Mexico, also extending north into southern parts of Texas and California. As pointed out elsewhere, the writers believe that this species is the form from California described by Stål (Freg. Eugen. Resa, Ins., 1859, p. 265) as *Gerris franciscanus.* If this be true the name *franciscanus* will have priority. *Guerini* exhibits great variation in size and length of appendages, also much more variation in color and markings than its congeners.

3. **Limnogonus recens,** sp. nov. (Pl. XXV, fig. *c*)

Limnogonus hyalinus Champion, Biol. Centr.-Amer., Rhyn. II, 1898, p. 153, Pl. IX, fig. 18; Torre-Bueno, Trans. Am. Ent. Soc., XXVII, 1911, p. 245.
Tenagogonus hyalinus Drake and Harris, Ohio Jour. Sci., 1928, XXV, p. 273.

Apterous form: Moderately large, black, shiny, the head with two longitudinal vittæ united posteriorly to form a yoke-like mark, two short stripes on front lobe of pronotum, a narrow median stripe on the margins of posterior lobe and a short stripe on the antero-lateral margins flavous to ochraceous. Antennæ brownish black; proportions—(male) 90:75:62:84, (female) 88:65:52:80. Rostrum moderately long, last segment black, not quite extending to middle of mesosternum. Pronotum with the anterior lobe slightly raised in male, the posterior lobe extending upon metanotum in both sexes, broadly rounded behind. Fore femora slightly incrassate, faintly curved; the tibiæ darkened at apex; tarsi blackish. Body beneath testaceous.

Winged form: Markings as in apterous individuals. Humeri moderately prominent. Hemelytra blackish, brownish along the inner margin, the nervures prominent.

♂. Intermediate and posterior acetabula above silvery. Abdomen above with a median brownish stripe. Connexiva moderately broad, narrow but not produced at apex, the third, fourth and sometimes fifth segment with a silvery or brown spot. Venter with last segment nearly as broad as two preceding, arcuately emarginate at apex. First genital segment beneath conspicuously raised and strongly produced at the middle behind, terminating in a point (Pl. XXV, fig. *c*).

♀. Connexiva broader, usually with brownish spots on all but first and last segments, terminating behind in short sharp processes. Last segment of venter about as long as the two preceding, slightly produced at the middle.

Size: Length, 7.50-10.00 mm.; width, 1.40-2.10 mm.

Holotype, apterous male, and *allotype,* apterous female, Punta Gorda, British Honduras, in collection of the authors. *Paratypes,* numerous apterous and winged males and females, taken with types, and from Los Amates, Guatemala and from Panama City, Panama. Heretofore, this species has been considered by the writers and most other American workers as *L. hyalinus* Fabr. The latter, however, is quite different, having a much larger and more strongly produced keel beneath on the first genital segment of the male. We are indebted to Dr. H. B. Hungerford of the University of Kansas for a sketch of the genitalia of the type of *hyalinus*, and to Mr. W. E. China of the British Museum of Natural History for the privilege of examining the specimens, from Panama, figured by Champion as *L. hyalinus* Fabr. The outline drawings of the lateral aspect will serve to separate the two species.

4. **Limnogonus hyalinus** (Fabr.) (Pl. XXV, fig. *b*)

Hydrometra hyalinus Fabricius, Syst. Rhyng., 1803, p. 258.
Limnogonus hyalinus Stål, Hemip. Fabr., I, 1868, p. 133.

Apterous male: Large, robust, brownish black, the abdomen darker; the sides of the acetabula and the connexivum above in a large measure clothed with silvery pubescence. Head with a longitudinal line on each side above and a basal transverse streak brown. Rostrum brownish testaceous, black at apex, reaching to the front third of the mesosternum. Antennæ dark brown, the basal segment a little lighter; proportions, 90:75:58:78. Pronotum brownish black, anterior lobe tumid, its disc depressed and with two short reddish brown stripes; posterior lobe very strongly produced, extending over part of metanotum, with the median longitudinal streak extending upon the basal portion of anterior lobe, the margins flavous. Abdomen above with a median rufous line on last five segments. Connexiva moderately broad, triangularly produced at apices. Body beneath testaceous. Mesosternum broadly channeled in front. Front legs brownish, the base of femora, coxæ and trochanters testaceous; femora moderately incrassate, slightly curved. Venter somewhat flattened beneath, the last segment about as long as the two preceding, subtruncate behind, with a broad blackish streak on each side. Sides of thorax above and intermediate acetabula dark reddish brown. First genital segment beneath very strongly produced and tapering posteriorly, the apical plate darkened, flattened, and abruptly bent downward (Pl. XXV, fig. *b*); above broad, blackish, constricted at the base, with a short median basal streak and part of the hind margin brownish. Second genital segment short, broad and plump.

Size: Length, 8.65 mm.; width, 1.70 mm.

Panama, Trinidad, French Guiana, Brazil, and Ecuador. Male specimens from Trinidad are at hand. The writers are greatly indebted to Dr. H. B. Hungerford for a sketch of last venter and genital segments and also descriptive notes of the Fabrician type, without which it would have been impossible to locate the species. Heretofore, *L. recens*, sp. nov, has been wrongly identified by the writers, Torre-Bueno and others as *L. hyalinus*. The Florida record of *hyalinus* probably represents an erroneous identification. The species is easily known by the genital characters of the male. In one of the specimens at hand the terminal, downwardly bent tip of the plate at the apex of the first genital segment is broken off.

5. **Limnogonus profugus** Drake and Harris

Limnogonus profugus Drake and Harris, Ann. Carn. Museum, XIX, 1930, p. 237.

Allied to *recurvus* D. & H. in size, color, and markings, but readily distinguished from it by the structure of sixth venter and genital segments. Antennæ brown to dark brown, the last segment darker; proportions—(male) 98:70:72:82, (female) 95:66:58:80. Rostrum with last segment black, extending upon mesosternum.

Apterous form: Pronotum reddish brown; the anterior lobe considerably raised in male, scarcely elevated in female, blackish, with two short ochraceous stripes on the disc, the antero-lateral margins with a flavous line on each side; posterior lobe extending to metanotum, with a median longitudinal line and the margins flavous. Sides of thorax with broad blackish stripe, beneath clothed with grayish pubescence; acetabula above silvery pubescent.

Winged form: Pronotum darker, humeri moderately prominent; anterior lobe depressed on the disc. Hemelytra blackish, nervures prominent and darker.

♂. Sixth venter very deeply, broadly and roundly emarginate behind. First genital segment plump, without keel, transversely impressed near the base.

♀. Sixth venter broadly convex at the middle behind, shorter than the two preceding segments. Connexiva scarcely produced apically.

Size: Length, 7.50-10.60 mm.; width, 1.60-2.00 mm.

Holotype, winged male, and *allotype*, winged female, from Chapada, Brazil, H. H. Smith, are in the Carnegie Museum. Numerous other specimens have been seen from Brazil and Paraguay.

The series show that there is considerable range in size, and variations in color markings, and in lengths of antennal segments. In some examples the sides of the thorax tend to be much darker than in others. The sixth venter in the female is not as acutely produced at the middle behind as in *L. aduncus*, neither are the terminal connexival spines as long nor as acute.

6. **Limnogonus aduncus** Drake and Harris (Pl. XXIV, fig. *l*)

Limnogonus aduncus Drake and Harris, Psyche, XXXIX, 1933, p. 110.

Apterous ♂. Size and general aspect similar to *Limnogonus recurvus* D. & H., the head and pronotum with similar markings.

Antennæ dark brown; proportions, 104:88:68:87. Rostrum dark brown, the apical segment blackish, reaching upon the anterior portion of mesosternum. Front legs dark brown. Pronotum black, indistinctly margined with fulvous; anterior lobe moderately tumid, with two short ochraceous lines on the disc; posterior lobe broadly rounded behind, extending upon base of metanotum, with a median ochraceous line. Abdomen above with a median longitudinal ochraceous line. Body beneath yellowish brown with grayish pubescence, the mesosternum large, the venter sometimes with a broad, blackish, submarginal stripe.

Connexivum moderately broad, slightly produced at apex, segments two, three, and four each with a prominent pale or silvery spot. Venter somewhat flattened, hairy along posterior margin, the last segment almost twice as long as the preceding. Genital segments large, dark brown, the first segment impressed on each side of a median raised portion which becomes narrowed posteriorly and ends in a distinct brownish black recurved or hook-like projection.

Apterous ♀. Broader and stouter than male, brownish black. Finely pubescent, the sides of pronotum, the intermediate and posterior acetabula, and second and third segments of connexivum silvery. Antennæ brownish; proportions, 108:80:70:95. Abdomen above with a broad, median, longitudinal flavous to fulvous stripe. Connexiva distinctly, angularly produced behind; sixth venter nearly twice as long as preceding, its hind margin more sharply concavely produced at the middle than in *profugus* (Pl. XXIV, fig. *l*).

Winged form: Pronotum with the humeri raised and prominent, the anterior lobe depressed on the disc, with two short fulvous stripes. Hemelytra brownish black, reaching beyond tip of abdomen.

Size: Length, 8.00-11.30 mm.; width, 1.60-2.40 mm.

Originally described from three specimens from Brazil, Comparative Zoology Museum, Harvard University. In addition a long series of specimens from Trinidad, British Guiana, Ecuador, Paraguay, and Brazil have been examined. These exhibit considerable variation in size and some differences in the lengths of the antennal segments. The antero-lateral stripe of the pronotum may or may not be developed, often being reduced to a small spot behind each eye. In the male the mesosternum is broadly and shallowly depressed, there clothed with longer pile.

7. **Limnogonus recurvus** Drake and Harris (Pl. XXIV, figs. *j* and *k*)

Limnogonus recurvus Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 236.

Apterous form: Fuscous to blackish, a line on each side of head above near the eyes, these connected at base of head, two short stripes on disc of anterior lobe of pronotum, a medium stripe and margins of posterior lobe yellowish to ochraceous. Antero-lateral margins of pronotum with a yellowish to silvery stripe. All acetabula and the middle and hind coxæ, dark brown, with silvery pubescence. Second, third, and fourth segments of connexiva and sometimes the sides of abdomen above with silvery pubescence. Body beneath yellowish testaceous, the sides of thorax brownish to blackish, sides of venter with a broad, brownish black to black vitta.

♂. Antennæ brownish fuscous, the terminal segments darker; formula, 100:74:56:82. Connexiva broad, angularly produced behind. The median longitudinal stripe on the dorsum extending to last genital segment. Posterior portion of mesosternum and the metasternum broadly depressed, clothed with longer pile. Last venter truncate, about as long as the two preceding segments conjoined. First genital segment strongly produced at the apex, terminating in a dark brown, recurved hook, with a large, rounded protuberance in front of the hook (Pl. XXIV, fig. *k*).

♀. Antennal formula, 100:66:55:85. Sixth venter nearly as long as the two preceding, convexly produced at the middle behind (Pl. XXIV, fig. *j*). Fifth venter sinuate along the hind margin. Connexiva broadly angularly produced behind. Metasternum shallowly sulcate in front.

Size: Length, 9.16 mm.; width, 1.60-1.90 mm.

Known only from the type locality, Chapada, Brazil. The winged form is unknown. The male genital characters are very different from those of any other species in the genus.

8. **Limnogonus hesione** (Kirkaldy) (Pl. XXIV, fig. *d*)

Gerris hesione Kirkaldy, Entomologist, XXXV, 1902, p. 137.

Tenagogonus hesione Barber, Bull. Am. Mus. Nat. Hist., XXXIII, 1914, p. 499; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 273.

Limnogonus hesione Osborn and Drake, Ohio Nat., XV, 1915, p. 503, fig. 1; Blatchley, Heteroptera E. N. Amer., 1928, p. 179, fig. 194.

Black, a transverse spot on base of head, the margin of hind prolongation of pronotum, and a spot on anterior lobe flavous to fulvous. Pronotum indistinctly carinate, the humeri prominent. Abdomen rather short, somewhat abbreviated. Body beneath with a silvery bloom. Hemelytra brownish black, reaching considerably beyond tip of abdomen; nervures prominent. Antennal proportions, 64:36:38:39.

Apterous form: Oblong-oval, moderately robust. Pronotum short, with an elongate median fulvous spot; slightly produced posteriorly in male; hind lobe a little more strongly developed in female, covering a small fraction of the front portion of mesonotum. Mesonotum large, strongly convex. Connexiva in male rather narrow, not produced at apex; in female very broad, truncate behind.

♂. Genital segments as in Pl. XXIV, fig. *d*.

♀. Sixth venter about as long as two preceding segments.

Size: Length, 4.50-7.92 mm.; width, 1.40-1.80 mm.

Widely distributed in Eastern United States, and largely found in ponds and lakes. Specimens have been examined from New York, Ohio, Michigan, Kansas, West Virginia, Georgia, Florida, Alabama, Mississippi, Louisiana, Missouri, Iowa, Illinois, Nebraska, Texas, Tennessee, Arkansas, Virginia, Pennsylvania, Kentucky, Indiana, and South Carolina. Kirkaldy's types from Florida and Panama are in U. S. National Museum. The winged form is quite common in the south and rather rare in the north.

9. **Limnogonus lubricus** White.

Limnogonus lubricus White, Jour. Linn. Soc. Lond., Zool., XIV, 1879, p. 489; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210.

Apterous form: Very small, black; a spot on disc of anterior lobe of pronotum and margin of posterior lobe ochraceous. A broad stripe on side of thorax, acetabula, most of abdomen above, and body beneath rather silvery. Antennæ brown, the apices of first and second segments and all of third and fourth blackish; proportions—(male) 46:26:27:36, (female) 52:32:32:38. Anterior legs dark brown, the trochanters and base of femora lighter. Mesosternum channeled anteriorly. Prosternum yellowish. Body widest through acetabula of middle legs, thence narrowed anteriorly and more strongly so posteriorly. Sides of thorax blackish above. Anterior tibiæ slightly curved, the tarsi black. Posterior lobe of pronotum covering the mesonotum.

♂. Sixth venter nearly as long as the two preceding, slightly emarginate behind. First genital segment narrowed posteriorly, beneath distinctly transversely impressed on each side. Connexiva rounded above, narrowed posteriorly, not produced behind. Second genital segment, as seen from above, small, narrowed toward tip.

♀. Abdomen broader and longer than in male, connexiva much broader, truncate behind. Last venter very long, as long as the two preceding segments, slightly convex apically.

Winged form: Pronotum with an indistinct median carina on posterior lobe; humeri moderately prominent. Hemelytra dark brown, the nervures raised and slightly darker.

Size: Length, 3.50-5.10 mm.; width, 1.30.

This is the smallest member of the genus known to occur in the Western Hemisphere. As in the other species with abbreviated abdomen, winged individuals are considerably longer than apterous ones. Many specimens have been examined from Brazil, British Guiana and Dutch Guiana. Identification is based on a pair of paratypes kindly loaned the writers by Mr. W. E. China of the British Museum.

10. **Limnogonus lotus** White

Limnogonus lotus White, Jour, Linn. Soc. Lond., Zool., XIV, 1879, p. 488; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Drake and Harris, Ann. Carnegie Mus., XIX, 1930, p. 236.

Apterous form: Rather small, black, basal margin of head, a spot on disc of anterior lobe of pronotum and the margin of hind lobe ochraceous. Sometimes head with more or less distinct longitudinal lines. Silvery pubescence not as conspicuous as in *lubricus*. Anterior lobe of pronotum prominent, distinctly marked off, the posterior lobe extending a little beyond middle of mesonotum. Antennal proportions, (female) 60:41:32:43. Anterior legs yellowish brown, a large dark spot on the femora behind and the tibiæ and tarsi blackish; femora short, much stouter than in related species. Mesonotum raised, tumid.

♂. Last venter about two-thirds as long as the two preceding segments together, the apex feebly, broadly, roundly, excavated behind. First genital segment indistinctly impressed on each side. Connexivum narrowed posteriorly. First genital segment above slightly concave, subtruncate at the apex, the second small and narrowed to the tip.

♀. Much broader than the male, also much broader than female of *lubricus*, practically as broad as *celeris*, sp. nov. Last dorsum almost as long as the two preceding but not so strongly narrowed posteriorly as in *celeris*. Sixth venter nearly as long as the two preceding, the hind margin faintly sinuate.

Winged form: Anterior lobe of pronotum also more prominent than in related species. Hemelytra brown, the nervures raised and darker.

Size: Length, 5.60-6.70 mm.; width, 1.20-1.85 mm.

Specimens from British Guiana and Brazil, including a pair of paratypes have been examined. The species is probably most closely allied to *celeris*, sp. nov.

11. **Limnogonus genticus,** sp. nov.

Apterous ♂. Small, black, shiny. Head black, margined with ochraceous behind. Antennæ brown, the apex of first and second and all of last two segments blackish; proportions, 45:22:22:33. Body beneath bluish, the sides of thorax above blackish. Front legs blackish, the basal portion of femora and trochanter testaceous; tibiæ slightly curved, the femora stout. Rostrum reaching a little beyond the prosternum, bluish brown, dark at apex. Sixth venter about two-thirds as long as the two preceding segments conjoined, slightly, broadly, roundly excavated behind. Connexivum narrowed posteriorly, not produced behind, without markings. Middle and hind legs brownish. First genital segment beneath tapering posteriorly, slightly transversely depressed at the base, broadly and shallowly excavated behind; above rounded behind as in *lubricus* White. Second segment narrowed toward tip. Abdomen narrowed apically. Pronotum with the front lobe slightly raised, faintly depressed on the disc, there with a large ochraceous spot; posterior lobe largely margined with yellowish brown, rounded behind, extending to middle of mesonotum. Mesonotum tumid, slightly raised posteriorly, with an indistinct median impressed line.

Size: Length, 4.15 mm.; width, 1.20 mm.

Holotype, apterous male, Santarem, Brazil, collection of authors. The size and the nature of the pronotum serve to distinguish this insect from related species. The winged form is unknown.

12. **Limnogonus celeris,** sp. nov. (Pl. XXV, fig. *a*)

Apterous form: Small, a little larger than *lubricus* White. Black, a spot on base of head, an oblong spot on disc of anterior lobe of pronotum, and entire border of posterior lobe flavous to ferrugineous. Antennæ dark brown, segments I and II except tips paler; proportions—(male) 50:31:26:37, (female) 58:38:33:42. Anterior legs testaceous, a short stripe on apical half of femora, and entire tibiæ and tarsi blackish. Rostrum testaceous, the tip blackish, extending on front portion of mesosternum. Posterior legs brownish testaceous, the tarsi darker. Sides of mesothorax black. Mesosternum narrowly channeled in front.

♂. Anterior lobe of pronotum moderately tumid, the disc distinctly impressed; posterior lobe covering the mesonotum, narrower than in female. Connexivum scarcely produced at the apex. Body beneath largely bluish, the prosternum and anterior portion of mesosternum testaceous. Last venter subtruncate, shorter than the two preceding segments together, mostly brownish. First genital segment above rather deeply emarginate at apex, about twice as broad as in *lubricus* and slightly narrower than in *lotus*; testaceous to bluish gray beneath, with a narrow transverse impression on each side (Pl. XXV, fig. *a*). Last genital segment beneath plump; above very narrow and pointed at tip.

♀. Broad, as in *lotus*. Pronotum impressed on the disc of front lobe, the posterior lobe extending over mesonotum. Abdomen very broad, the connexiva somewhat rounded at the apex. Body beneath largely testaceous, a large spot on basal portion of meso- and metasternum, and narrow interrupted spots on the venter dark brown. Last segment of venter almost as long as the two preceding ones together, subtruncate behind.

Size: Length, 5.00-5.70 mm.; width, 1.00-1.20 mm.

Holotype, apterous male, and *allotype*, apterous female, Villa Rica, Estero Grande, Paraguay, Feb. 1, 1924, F. Schade; collection of University of Kansas. *Paratypes*, two males and one female taken with type. The notch at the apex of the first genital segment serves readily to identify the male.

13. **Limnogonus visendus,** sp. nov.

Apterous form: Moderately large, slender; black, a spot on disc of pronotum and a broad yoke-like mark on head above ochraceous to ferrugineous. Antennæ brownish black, the first segment, except apex, paler; proportions, 45:26:26:32. Rostrum reaching on front portion of mesosternum, segment II and III very dark and shiny. Pronotum short, not produced posteriorly, impressed on disc. Mesonotum sharply delineated, moderately tumid, highest behind the middle, rounded behind. Anterior femora moderately bowed, the distal three-fourths blackish; tibia curved, dark brown; tarsi darker. Body beneath clothed with a dense bluish pile; the sternum and venter flattened. Middle and hind legs dark brown, the tips of femora darker. A spot on middle and hind acetabula and one on each side of fourth, fifth, and sixth abdominal tergites and also corresponding connexival segments silvery.

♂. Abdomen truncate behind. Connexiva not produced at apex. Venter slightly flattened, the sixth segment a little longer than preceding, broadly roundly emarginate behind. First genital segment above rather long, sub-cylindrical, truncate behind; second segment short, coniform; beneath, first segment transversely impressed at the base, the hind margin roundly emarginate, the second segment with a distinct tuft of pale hairs on each side.

♀. Slightly more robust than male, the connexiva not produced behind.

Size: Length, 5.00-5.40 mm.; width, 1.20 mm.

Holotype, apterous male, and *allotype*, apterous female, Rio Branco (Brazil), Haseman; in collection of Vienna Museum. *Paratype*, male, in authors' collection.

This species is easily recognized from its congeners. The body is only moderately shiny and the abdomen is noticeably long for the group of species to which it belongs.

III. Genus TENAGOGONUS Stål, 1855

Haplotype, *albovittatus* Stål

Tenagogonus Stål, Öfv. Vet.-Akad. Förh., X, 1853, p. 263 (*nomen nudum*); Stål, *ibid.*, XII, 1855, p. 45; Stål, Hemip. Afr., III, 1865, p. 168; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209; Bergroth, Zool. Med. Rijks. Mus. Nat. Hist., I, 1915, p. 123.

Limnometra Mayr, Verh. Zool. Bot. Ges. Wien., XV, 1865, p. 443; Mayr, Reise Freg. Novara, Zool., II, 1868, p. 175; Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 150.

Moderately elongate, dull, finely pubescent. Antennæ long, slender, about as long as or slightly longer than the entire body; segments I and II moderately stout, III and IV filiform, IV longest. Eyes exserted. Rostrum long. Anterior tarsal segments subequal in length. Intermediate and posterior legs very long, their femora extending far beyond the apex of abdomen.

Three species of water striders occurring in the Western Hemisphere are referable to this genus. In all, the middle and posterior acetabula as seen from above are marked with conspicuous, silvery sericeous spots. Only winged forms are known for the described American species; however, Champion recorded one wingless specimen (species uncertain) from Central America.

KEY TO SPECIES OF *Tenagogonus*

1. Head and front lobe of pronotum with prominent black markings. Length of antennal segment I slightly greater than width of head thru eyes. Sixth venter deeply notched at middle behind in male (Pl. XXIV, fig. *g*); broadly convexly rounded in female..............*quadrilineatus* (Champ.), p. 216

Head and pronotum in front not or only indistinctly marked with darker lines, these never black. Antennal segment I in length equal to width of head thru eyes. Sixth venter at apex not distinctly notched in middle in male; subangulately or subquadrately produced in female.................. 2

2. Male with prominent tubercule on inner side of front femur before base. Genital segments of male as in Pl. XXIV, fig. *i*; sixth venter subquadrately produced at apex in female (Pl. XXIV, fig. *h*).....*celocis* D. & H., p. 218

Front femur of male not tuberculate. Genital segment of male as in Pl. XXIV, fig. *f*; female with apex of venter distinctly, subacutely, produced in middle at apex...............................*opacus* (Champ.), p. 217

1. **Tenagogonus quadrilineatus** (Champion) (Pl. XXIV, fig. *g*)

Limnometra quadrilineata Champion, Biol. Centr.-Amer., Rhynch., II, 1898, pp. 150, 151, pl. IX, fig. 17.

Tenagogonus quadrilineatus Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., 1908, p. 209; Drake and Harris, Ohio Jour. Sci., XXVIII, 1928, p. 273.

Moderately narrow, opaque, head fulvous to ochraceous, with black markings. Rostrum reaching to front third of mesosternum. Antennæ dark brown; proportions—(male) 73:52:80:95, (female) 86:60:80:95. Anterior lobe of pronotum concolorous with head, with four blackish stripes; posterior lobe usually much darker, obsoletely carinate down the middle. Hemelytra fuscous black. Mesosternum with broad median channel.

♂. Metasternum with a very prominent median carina. Connexiva not produced at apex. Sixth venter very strongly impressed behind, broadly, deeply, and roundly emarginate in middle at apex (Pl. XXIV, fig. *g*).

♀. Connexiva terminating in moderately long spines. Sixth venter very strongly, broadly, and roundly produced behind, as long as the two preceding segments, usually concealing the genital segments.

Size: Length, 6.20-11.00 mm.; width, 2.00-2.80 mm.

Recorded from Mexico and Nicaragua by Champion. Specimens have been seen from Paraguay, Costa Rica, Honduras, Guatemala, and Mexico. There is quite a range in size and considerable variation in color markings and in the length of the antennæ in both sexes. Two forms of macropterous individuals occur in *quadrilineatus*, one with hemelytra reaching beyond the tip of abdomen and the other with them considerably shorter, not attaining the apex of the last dorsum. The structure of the sixth venter, together with the nigrolineate head and pronotum are quite distinctive characters.

2. **Tenagogonus opacus** (Champion) (Pl. XXIV, fig. *f*)

Limnometra opaca Champion, Biol. Centr.-Amer., Rhynch., II, p. 150, Pl. IX, 1898, figs. 16, 16a.

Tenagogonus opacus Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 209.

Rather narrow, opaque, brownish ferrugineous above, pale ochraceous beneath. Head with a streak on each side between the eyes and a spot in front dark brown to black. Antennæ very slender, dark brown, the basal segment curved; formula—(male) 65:48:92:115, (female) 75:58:92:125. Pronotum reddish brown, with a fairly distinct median carina, anterior lobe with a more or less distinct, posteriorly-narrowed, median, pallid line, the antero-lateral margins with a pale testaceous stripe; posterior lobe darker. Rostrum reaching almost to middle of mesosternum. Mesosternum more broadly and deeply channeled along the middle anteriorly.

♂. Connexiva not terminating in spines. Metasternum with a very distinct median carina. Sixth venter a little longer than the preceding, very broadly and roundly emarginate behind (Pl. XXIV, fig. *f*). Median line on anterior lobe of pronotum sometimes obsolete.

♀. Connexiva terminating in short, stout spines. Sixth venter almost as long as the two preceding, subacutely produced in the middle at apex. Posterior margin of pronotum much more broadly rounded behind than in male.

Size: Length, 6.00-9.10 mm.; width, 1.75-2.30 mm.

Described by Champion from specimens from Panama. In addition to a male cotype from Bugaba, the writers have examined numerous specimens from Guatemala, Costa Rica, Nicarauga, British Honduras, and Panama. In this and the following species the submarginal groove of the hind lobe of the pronotum is densely filled with golden pubescence.

3. **Tenagogonus celocis** Drake and Harris (Pl. XXIV, figs. *h* and *i*)

Tenagogonus opacus Drake & Harris, Ann. Carn. Mus., XIX, 1930, 235.
Tenagogonus celocis Drake & Harris, *ibid.*, XX, 1931, 267.

Similar to *opacus* Champ. in size, general color and markings, but with the silvery spots on the antecoxal plates more prominent. Antennal proportions—(male) 70:50:90:115, (female) 76:57:80:170. Rostrum reaching to about the middle of mesosternum. Hemelytra dark brown, the nervures prominent. Antero-lateral margins of pronotum with a pale stripe. Mesosternum with median longitudinal channel; the metasternal carina only moderately prominent.

♂. Anterior femora slender, strongly curved, distinctly carinate within on the basal third, the carina becoming more strongly raised distally and there terminating abruptly to form a conspicuous elevation. Sixth venter as long as the two preceding segments, slightly longer than in *opacus*, and much shorter than in *4-lineatus*, very broadly, roundly excavated behind (Pl. XXIV, fig. *i*).

♀. Much larger and stouter than male. Front femora slightly curved, unarmed. Connexiva terminating in short, strong spines. Sixth venter nearly twice as long as the preceding segment, strongly, subquadrately produced at the middle behind.

Size: Length, 6.30-8.10 mm.; width, 1.80-2.54 mm.

The *holotype* (male) and *allotype* (female) from Chapada, Brazil, H. H. Smith, are in the Carnegie Museum. Readily distinguished from its congeners by the anterior femora in the male and the hind margins of sixth venter in the female. This is the only American member of the genus having the anterior femora armed in the male.

IV. Genus CYLINDROSTETHUS Mayr, 1865

Haplotype, *fieberi* Mayr, 1865 (=*producta* Spinola, 1840)

Hydrobates Erichson, in Schomburgk's Faun. Brit. Guiana, III, 1848, p. 614 (*nec.* Boie).

Cylindrostethus Fieber, Europ. Hemip., 1861, p. 33 (invalid); Mayr, Verh. Zool. Bot. Ges. Wein., XV, 1865, 444; Kirkaldy, Entomologist, XXX, 1897, 258; Bergroth, Ent. Mo. Mag., XIII, 1902, p. 258; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 210; Schmidt, Stett. Ent. Zeit., 76, 1915, p. 361; Torre-Bueno, Spolia Zeylandica, 13, 1925, p. 226.

Janias Distant, Fauna Br. Ind., Rhynch., V, 1910, p. 148; Esaki, Ann. Mag. Nat. Hist., (10) 4, 1929, p. 416.

Body very elongate, cylindrical; antennæ rather slender, moderately long; intermediate and posterior legs extremely long, their femora extending to or even a little beyond the last genital segment; front tarsi with segment II twice as long as I. Rostrum short, not attaining middle of prosternum. Eyes large, long, not exserted, placed obliquely on the sides of the head. Metasternum divided by a sinuate, transverse suture a little before hind margin. In apterous form pronotum rather short, not produced behind over mesonotum.

This genus is represented in the Western Hemisphere by five species, two of which are described below as new. Winged forms of American species are as yet unknown.

In the exotic *C. quadrivittatus* Bergroth, the male genital segments are asymmetrical, and the femora of the middle and hind legs extend far beyond the tip of the abdomen. In these and other characters it shows decided affinities with *Potamobates* Champion.

KEY TO SPECIES OF *Cylindrostethus*

1. Mesonotum unicolorous, brownish to brownish black, longitudinally impressed along the sides. Sixth venter of male doubly emarginate at apex (with a deep notch at the middle) 2
   Mesonotum brownish, with conspicuous fuscous to black longitudinal stripes. Sixth venter of male with a broad simple emargination at apex (without median notch) 3

2. Mesonotum dark, fuscous to blackish. Male venter and genital segments as in Pl. XXV. fig. *e*. First genital segment above of female as long as broad, narrowed distally, the apex broadly rounded....*erythropus* (H.-S.), p. 219.
   Mesonotum brownish. Male venter and genital segments as in Pl. XXV, fig. *f*. *linearis* (Erich.), p. 220

3. Length of first antennal segment subequal to width of head thru eyes. *hungerfordi*, sp. nov., p. 221
   Length of first antennal segment distinctly greater than width of head thru eyes 4

4. First two antennal segments black. Connexival spines of male reaching to middle of first genital segment. Female with connexival spines long, reflexed, and contiguous above genital segments; first genital above longer than broad, ending in acute point..............*palmaris*, sp. nov., p. 222
   First two antennal segments paler, largely testaceous. Connexival spines shorter, not reaching to middle of first genital segment in male (Pl. XXV, fig. *g*). Female not as above ....*regulus* (White), p. 222

1. **Cylindrostethus erythropus** (Herrich-Schaeffer) (Pl. XXV, fig. *e*)

Hydrometra erythropus Herrich-Schaeffer, Wanz. Ins., IX, 1850, p. 68, fig. 923.
Cylindrostethus erythropus Schmidt, Stett. Ent. Zeit., 76, 1915, p. 362.

Elongate, brownish black to black, the margins of connexiva and sometimes median line of pronotum and part of head above brown; clothed with short, fine, golden pubescence. Antennæ brownish black; proportions, 92:40:28:50. Mesonotum longitudinally impressed on each side. Abdomen above brownish black. Mesosternum testaceous. Fore femora brownish above, largely brownish black beneath; tibiæ and tarsi blackish. Intermediate and posterior legs brown, the apices of tibiæ and tarsi darker.

♂. Abdomen distinctly widened posteriorly, the connexival spines very stout, extending almost to apex of first genital segment. Venter with the last two or three segments impressed along the middle, the last segment broadly, roundly excavated in the middle at the apex, there forming a deep median notch. First genital segment beneath plump, slightly impressed on each side; above subquadrate, flattened distally, impressed within along the lateral margins posteriorly, convexly rounded behind. Last genital segment above conical, shorter than first, produced on each side into long, strong, triangular projections, which extend almost to the end of first genital segment (Pl. XXV, fig. *e* and *é*).

♀. Connexival spines much shorter than in male, directed posteriorly. Sixth venter subtriangularly produced at middle behind. First genital segment impressed on each side beneath; above broad at base, narrowed posteriorly, truncate at apex. Last genital segment pointed, about as long as the preceding one.

Size: Length, 14.50-15.50 mm.; width, 1.90-2.00 mm.

Type locality, Brazil. In the Kansas University collection there is a series of sixty-seven specimens from Solimoes River, Manacapuru, Amazonas, Brazil, March and April, 1926, collected by S. M. Klages.

2. **Cylindrostethus linearis** (Erichson) (Pl. XXV, fig. *f*)

Hydrobates linearis Erichson, in Schomburgk's Fauna Brit. Guiana, III, 18, p. 614.

♂. Elongate, brownish black, the abdomen slightly widening posteriorly; connexival margins paler, the apical spines shorter and much slenderer than in *erythropus* (H.-S.). Last venter impressed at the base, the apical margin hairy, deeply and roundly excavated at the middle, the median tooth shorter, more strongly reflexed and more inconspicuous than in *erythropus*. First genital segment beneath plump, faintly impressed on each side; above strongly longitudinally impressed on each side of median line behind, thus leaving the lateral margins distinctly raised. Second genital segment above long, slender, cylindrical on basal half, then narrowed and terminating in a point; the ventral antero-laterally projecting plates considerably narrower than in *erythropus* (Pl. XXV, fig. *f*). Antennæ brownish black; proportions, 90:36:26:50.

♀. Very similar to *erythropus*. Connexival spines short. Antennæ darker than in male.

Size: Length, 14.00-15.00 mm.; width, 1.90-2.00 mm.

A male and female each labelled "*H. linearis, Type, Brit. Guyana, Schomburgk*" have been made available for our study through the kindness of Dr. W. Rammé, Zoologisches Museum der Universitat, Berlin. A male from Rio Javary, Brazil, 1874, Traile collection, kindly sent for study by Mr. W. E. China of the British Museum, apparently belongs to the same species. *Linearis* is very closely related to *erythropus* H.-S.

3. **Cylindrostethus hungerfordi,** sp. nov.

Brown, somewhat shiny, with blackish markings. Antennæ with first two segments black; proportions, 107:40 (others wanting). Antennal tubercules black. Pronotum depressed in the middle. Mesonotum with a faint, median, longitudinal, depressed line; lateral stripe narrow, fuscous-black, sometimes largely wanting. Metanotum with an elongate blackish spot on each side. Abdomen above black, with a median, brown stripe. Anterior legs moderately large, femora beneath with numerous dark, bristly hairs, above with many blackish setæ near the base; tibiæ slightly curved, mostly black; tarsi black. Middle legs brownish, the femora with a longitudinal stripe on the basal three-fourths above, and a stripe on distal two-thirds beneath black. Hind legs dark brown, the femora above almost black. Body beneath pale brownish.

♂. Connexiva brown, slightly darker along the margin, terminating in short, sharp spines. First genital above cylindrical, about as long as broad; second segment narrow, long, pointed, slightly more than one and a half times as long as the first. Venter with a fairly distinct median keel, sixth segment very deeply, broadly, roundly emarginate behind, its margin clothed with numerous long hairs. First genital segment beneath cylindrical, faintly depressed on each side at the base, there quite hairy.

♀. Connexiva broader than in male, usually somewhat reflexed, terminating in moderately long spines which reach to middle of first genital segment. First genital segment above uniformly narrowed posteriorly; second scarcely longer than the first, ending in a long spine. First genital segment beneath compressed on each side, with short, dark setæ at the apex.

Size: Length, 19.00-22.00 mm.; width, 2.10 mm.

Holotype, apterous male, and *allotype*, apterous female, British Guiana, near New Amsterdam, South America, July 30, 1923, F. X. Williams; collection of University of Kansas. *Paratypes*, two males and two females, taken with types. The species is named in honor of Dr. H. B. Hungerford.

4. **Cylindrostethus palmaris,** sp. nov.

Cylindrostethus linearis Drake and Harris (*nec.* Erichson), Ann. Carn. Mus., XIX, 1930, p. 238.

Size and form similar to *regulus* White. Antennæ black, sometimes (male) the last two segments brownish; proportions, 112:46:32:55. The black stripes on thorax broader than in *regulus*.

♂. Connexiva brown, the terminal spines not quite reaching the middle of first genital segment. Last venter broadly, widely emarginate. First genital segment beneath plump, pilose. Last genital segment above long, pointed, the laterally projecting, plate-like structures small, brown.

♀. Thorax with a broad brownish black stripe along each side; mesonotum in some specimens with a small elongate patch of rather long, suberect, bristly, brown hairs on each side about one-third of the distance from the base. Connexiva greatly thickened and reflexed behind, the apices drawn out into rather long, brown spines which meet at their tips. First genital segment ending above in a short, black-pointed projection, beneath strongly impressed on each side and clothed with more numerous bristly brown hairs than in *regulus*; last segment with the spine fuscous black, long, much longer than in *regulus*.

Size: Length, 16.00-17.00 mm.; width, 2.00 mm.

Holotype, female, and *allotype*, male, Manacapura, Amazonas (Solimoes River) Brazil, June, 1926, S. M. Klages, Carnegie Museum.

Specimens are also at hand from British Guiana (near New Amsterdam), collected July 30, 1923, F. X. Williams; Cedros, Trinidad, B. W. I., August 20, 1921, collected by Aug. Busck; and Brazanca, Para, Brazil, Dec. 29, 1909. *Paratypes* in collections of University of Kansas, U. S. National Museum, Berlin Museum, and authors.

5. **Cylindrostethus regulus** (White) (Pl. XXV, fig. *g*)

Halobates regulus White, Journ. Linn. Soc. London, Zool., XIV, 1879, p. 488.
Cylindrostethus regulus Drake and Harris, Ann. Carn. Mus., XIX, 1930, p. 238.

Very elongate, rufo-testaceous, with prominent dark brown to fuscous-black markings. Antennæ largely brownish black, the apex of first and basal portion of second lighter; proportions, 125:45:34:55. Sides of abdomen and lateral margins of pronotum with broad, fuscous-black stripes. Abdomen above brownish black, usually with a rather distinct brownish, median line. Connexiva broad, brown, terminating in short sharp spines. Rostrum short, scarcely reaching to the prosternum, the last two segments black. Anterior femora darker on inferior surface, there with numerous short bristly hairs; tibiæ dark brown, broadened at apex; second tarsal segment twice as long as first. Intermediate and posterior legs very long and slender; femora extending beyond tip of last genital segment.

♂. Sixth venter depressed behind, very broadly and roundly excavated, and with numerous short hairs along the hind margin. First genital segment large, plump, cylindrical, with numerous short hairs along the sides and apical margin; last segment terminating above in a very long, sharp spine (Pl. XXV, fig. *g*).

♀. Venter with a faint median longitudinal ridge, last segment slightly sinuate behind. Last genital segment also terminating in a long spine. Connexiva strongly reflexed, each ending in a sharp, short spine.

Size: Length, 18.50-20.00 mm.; width, 2.10 mm.

Nova Olinda, Rio Purús, Brazil, collected by S. M. Klages, June, 1922, Carnegie Museum. Mr. W. E. China kindly furnished the writers with notes and drawings of White's type (female) in the Perth Museum, London.

Genus POTAMOBATES Champion, 1898

Logotype, *unidentatus* Champion

Potamobates Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 154; Kirkaldy, Trans. Amer. Ent. Soc., XXXII, 1906, p. 155; Kirkaldy and Torre-Bueno, Proc. Ent. Soc. Wash., X, 1908, p. 211.

Eyes oblique, not strongly exserted, coarsely faceted, feebly emarginate within posteriorly, rather narrowly separated anteriorly. Rostrum short, reaching to the mesosternum. Head subtriangular, produced and declivous in front. Anterior legs short, the femora stout and incrassate towards base; tarsi with basal segment short, less than half as long as the second; coxæ widely separated. Middle and hind legs very elongate, the former longer; femora of hind legs longer and slenderer than intermediate ones; second segment of hind tarsi much shorter than first. Thorax elongate-trapezoidal, widening to the intermediate acetabula; pleura prominent, rounded externally; pronotum short, not produced behind in apterous form, covering the mesonotum in the winged form. Mesonotum flattened and shiny in apterous individuals.

The genital segments are asymmetrical in the male, and also in the female in some species. The left side of the second genital segment is produced postero-laterally into a peculiar plate-like structure in the male in certain species, thus somewhat reminding one of the projections from this segment in *Cylindrostethus*; however, in American species belonging to the latter genus the genital segments are bilaterally symmetrical. Also it should be noted that the metasternum is divided by a transverse suture a little before its hind margin, the omphalium being placed in this suture as in *Cylindrostethus*. A few workers have erroneously considered the basal part of this division of the metasternum as the first segment of the venter, which in their opinion possesses seven visible segments instead of six. In both *Cylindrostethus* and *Potamobates* the anal opening is closed by a hard, circular, plate-like structure. Champion considered the genus to form a sort of connecting link between the *Gerrinæ* and the freshwater halobatine forms.

Six species are known from the tropical regions of the Americas. The writers have not seen examples of *williamsi*, *tridentatus*, *bidentatus*, and *unidentatus*.

KEY TO SPECIES OF *Potamobates*

1. Male 2
   Female 7

2. Genital segments with three prominent tooth-like projections (Pl. XXVI, fig. 1, *c-e*) 3
   Genital segments without definite tooth-like projections, or with only one or two, often however the second segment with a projecting, somewhat expanded rod-like structure 4

3. Genital segments as seen from above distinctly shorter than rest of abdomen; beneath the teeth, and the emargination of apex of last venter, as in Pl. XXVI, fig. 1, *c*, *d*, e .... *tridentatus* Esaki, p. 228
   Genital segments almost as long as rest of abdomen; the hook-like teeth farther separated, and the emargination at apex of last venter much narrower .... *williamsi* Hungerford, p. 228

4. First antennal segment distinctly longer than width of head thru eyes. First genital segment without distinct tooth-like process, second segment with prominent finger-like projection (Pl. XXV, fig. *h*) . . *osborni* D. & H., p. 225
   Length of first antennal segment not noticeably greater than width of head thru eyes. First genital segment with one or two definite acute teeth 5

5. Antennal segments II and III subequal. Genital segments with only one tooth .... *unidentatus* Champ., p. 227
   Antennal segment III distinctly shorter than II. Genital segments with two teeth 6

6. Middle and hind femora much longer than entire body. First genital segment with two teeth (Pl. XXVI, fig. *a*) .... *bidentatus* Champ., p. 227
   Length of middle and hind femora only slightly greater than that of entire body. First genital segment with only one tooth; second segment directly beneath it also toothed (Pl. XXVI, fig. *f*, *g*) .... *horvathi* Esaki, p. 226

7. Connexiva ending in long tapering processes (Pl. XXVI, fig. *b*) 8
   Connexiva not terminating in long tapering processes (Pl. XXVI, fig. *h*) . . 9

8. Connexival spines surpassing genital segments by half their length. Last segment of venter deeply angularly incised along apical margin, the incision cutting about half the length of the segment. . *williamsi* Hungerford, p. 228
   Connexival spines shorter. Last venter almost truncate at apex (Pl. XXVI, fig. *b*) . . . . *tridentatus* Esaki, p. 228

9. First antennal segment distinctly longer than width of head thru eyes. First genital segment above produced into a very long, tapering process, about as long as the 4 preceding segments together (Pl. XXV, fig. *h*) *osborni* D. & H., p. 225
   First antennal segment not noticeably longer than width of head thru eyes. First genital segment not greatly produced distally 10

10. Antennal segments II and III subequal. . . . . *unidentatus* Champ., p. 227
   Antennal segment II distinctly longer than III . . . . *horvathi* Esaki, p. 226

1. **Potamobates osborni** Drake and Harris (Pl XXV, fig. h)

Potamobates osborni Drake and Harris, Proc. Biol. Soc. Wash., 41, 1928, p. 25.

Broad, elongate; black, a broad stripe between the eyes, a narrow median stripe on the pronotum and body beneath ochraceous. Mesosternum with a rather large black spot on each side behind the middle; the pleura with a silvery pubescent stripe. Antennæ blackish; formula, 108:43:28:36. Intermediate and posterior legs very long, their femora as long as entire body.

♂. Connexiva moderately broad, scarcely produced behind. Last segment of abdomen nearly as long as the two preceding segments. Venter sulcate along middle, the sixth segment nearly as long as the two preceding ones; deeply, broadly, and roundly excavated behind in the middle, the margin hairy. Genital segments as long as rest of abdomen; first segment above convex, widest beyond the middle, subtruncate behind, beneath strongly concave, produced farthest posteriorly on the left side, the margin there thickened and without tooth-like projection. Second genital segment above much shorter and narrower than first, gradually narrowed posteriorly, the apex triangular; left side extending downward more than the right, its base with a flattened finger-like process, which projects postero-laterally. This process is slightly expanded at apex and arises from beneath the thickened margin of the first segment (Pl. XXV, fig. *h*).

♀. Connexivum narrowed posteriorly, the margin almost straight, the apex truncate. Last abdominal tergite almost as long as the two preceding. Fifth venter with a V-shaped notch in the middle of hind margin; the sixth truncate at apex, almost as long as the two preceding segments. First genital segment above black, convex, strongly narrowed posteriorly on basal portion, thence prolonged into an extremely long, gradually tapering, somewhat sinuous, rod-like structure; the entire segment about as long as the preceding four or five segments of abdomen. First genital segment beneath broad, flattened, subrectangular, forming a flap-like structure, the hind margin arcuately rounded. Second genital segment sub-conical, suspended beneath the enlarged basal portion of the first, convex and blackish above, considerably shorter than the rod-like process of first, the anal cap located near the tip.

Size: Length, 12.70 mm.; width, 3.60 mm.

Known only from the type series, Montzorango, Vera Cruz, Mexico; collection of Iowa State College. The antennæ and the genital segments of male and female readily serve to identify this species. The winged form is unknown.

2. **Potamobates horvathi** Esaki (Pl. XXVI, figs. *f* – *h*)

Potamobates horvathi Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 254, fig. 2; Drake and Harris, Proc. Biol. Soc. Wash., 41, 1928, p. 26.

Black and somewhat shiny above, pale brown to ochraceous beneath. Head brownish, with variable black markings, sometimes almost entirely black. Antennæ black; proportions—(♂) 72:41:22:42, (♀) 66:32:21:40. Thorax and abdomen above black, a broad longitudinal stripe on the pronotum, a long stripe on disc of mesonotum, the upper basal three-fourths of anterior femora, anterior and posterior trochanters and intermediate coxæ ochraceous. A broad stripe on sides of mesopleura, hind angles of mesonotum, and the intermediate and posterior acetabula above with silvery pubescence. Intermediate and posterior legs long, their femora about as long as body.

♂. Connexiva rather broad, the lateral margins slightly rounded, truncate at apex. Last abdominal tergite about as long as the two preceding. Venter with sixth segment impressed, nearly as long as the three preceding, the apex broadly roundly excavated. Genital segments above black, the first segment long, gradually narrowed posteriorly; beneath sub-cylindrical, ochraceous, the apical margin oblique, produced on left side into a tooth. Second segment above narrower than first, rounded behind, its left side extending downward farther than right side and at base produced into a sharp, flattened, triangular thumb-like tooth that projects from directly beneath the apical tooth of first genital. Second genital segment on left side with a posteriorly projecting tooth (Pl. XXVI, figs. *f* and *g*).

♀. Connexiva much broader than in male, very strongly reflexed and lying largely on surface of abdomen, not produced behind, the fourth, fifth, and sixth segments wider and more deeply scalloped. First genital segment above broad at base, about twice as long as broad, somewhat triangular in outline, its apex overlapping basal portion of second segment; the latter also black, rounded behind. Sixth venter about as long as the two preceding segments. First genital projecting behind in the form of a broad, obtusely-pointed plate-like structure (Pl. XXVI, fig. *h*).

Size: Length, 7.90-8.20 mm.; width, 2.60 mm.

Known from Colombia, Honduras, and Guatemala. The types from Mamatoca, Colombia, are deposited in the Budapest Museum. In the female the connexiva are a little narrower in winged specimens than in apterous individuals.

3. **Potamobates unidentatus** Champion

Potamobates unidentatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 155; Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 251.

Head shiny, with a posteriorly widened median vitta between eyes, and the sides in front ochraceous. Antennal segment I nearly or quite as long as II to IV united, II and III subequal, each shorter than IV.

Apterous form: Pronotum short, transverse. Mesonotum flattened, shiny, a median vitta, a small triangular spot on each side of it, and sometimes a line extending from the spots downwards ochraceous.

Winged form: Hemelytra extending considerably beyond the tip of abdomen, the wings about one-third shorter. Pronotum with a triangular patch at the base of anterior lobe, the sides and hind margin of posterior lobe, an elongate mark on the metanotum, connexival margins, coxæ and the trochanters and body beneath flavous or ochraceous.

♂. Sixth venter transversely depressed beyond the middle, the hind margin deeply arcuate-emarginate and ciliate. First genital segment beneath obliquely sulcate, its apical margin produced into a prominent tooth on the left side. Second genital segment broadly and angularly dilated on the right side near the base. Sixth connexival segment slightly produced at the outer apical angle, obtuse at the apex.

♀. Sixth connexival segment more pointed at outer apical angle than in male.

Size: Length, 8.00-10.00 mm.; width, 2.25-2.75. mm.

Types from Panama, British Museum. Also recorded from Mamatoca, Colombia, by Esaki. As the writers have not seen examples of this species, the above notes are based upon the original description.

4. **Potamobates bidentatus** Champ. (Pl. XXVI, fig. *a*)

Potamobates bidentatus Champion, Biol. Centr.-Amer., Rhynch., II, 1898, p. 155, pl. IX, figs. 22 and 22a.

Apterous form: ♂. Broad, elongate; black, with ochraceous and silvery pubescent markings. Antennæ with segment I nearly as long as II to IV conjoined, II and IV subequal in length, III considerably shorter. Pronotum short, transverse, depressed on disc, with a narrow median ochraceous line. Mesonotum about two and a half times as long as the pronotum, finely canaliculate down the middle behind, the channel continued on the metanotum. Sixth connexival segment rounded at the outer apical angle. Last venter transversely depressed beyond the middle, broadly arcuate-emarginate and ciliate behind. First genital segment above as long as the three preceding segments united, the lower apical margin produced on the left side into two prominent somewhat widely separated teeth. Second genital segment with a long projecting process which is visible between the two teeth of the preceding segment (Pl. XXVI, fig. *a*).

Size: Length, 11.00 mm.; width, 3.10 mm.

Known only from the type, male, Mexico; Mus. Holm.

5. **Potamobates tridentatus** Esaki (Pl. XXVI, fig. *b* – *e*)

Potamobates tridentatus Esaki, Ann. Mus. Nat. Hung., XXIII, 1926, p. 251, fig. 1.

Apterous form: Body black, more or less shining above, pale brown beneath. Head black, with a conspicuous triangular or anteriorly bifurcated spot on vertex. Antennæ rather short, black; segment I slightly shorter than remaining ones taken together, II and III nearly equal in length, IV about one and a half times as long as III. Pronotum short, transverse, black, with a large triangular spot at the middle pale brown; sometimes produced back over mesonotum. Mesonotum very long and broad, somewhat convex.

♂. Genital segments conspicuous, first segment somewhat tube-like from above, remarkably asymmetrical beneath, posterior margin obliquely cut from left to right, with two large teeth on right side behind; second segment with a long acute tooth projecting anteriorly from near the base (Pl. XXVI, fig. *c*-*e*).

♀. Connexiva strongly produced at their apices. Fifth segment of venter deeply, angularly emarginate behind. Genital segments very small, asymmetrical (Pl. XXVI, fig. *b*).

Size: Length, 8.50-11.00 mm.

Known only from Costa Rica. Types in Stockholm Museum. The above description and the figures are based upon Esaki's publication.

6. **Potamobates williamsi** Hungerford

Potamobates williamsi Hungerford, Bull. Brook. Ent. Soc., XXVII, 1932, p. 228.

Black above, marked with brownish spots and silvery patches; venter pale. Head light brown above. Antennæ largely dark brown, proportions, 10:3.2:3.6:4.7.* Pronotum black, with a large pale brown spot in the middle and silvery patches on the anterior half at the sides; transverse, its length slightly less than that of head. Meso-

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*The measurements here given are those of Dr. Hungerford, and were made with a scale different from that used in other descriptions in this paper. The writers have not examined specimens of this species.

notum bordered laterally with silvery pubescent bands and marked above by three variable, pale brown figures; slightly more than three times as long as pronotum, with a faint, median depressed line. Connexiva black, usually with pale spots on last segment beneath.

♂. Last segment of abdomen above a little longer than the two preceding ones. Connexiva triangularly produced behind. First genital segment above as long as the last four abdominal segments; in general shape much like that of *P. tridentatus* Esaki, but with the marginal teeth relatively larger and farther apart and the ventral margin with a much narrower concavity. Second genital segment with the hook-like tooth arising to the right of the median line and terminating between the other two teeth.

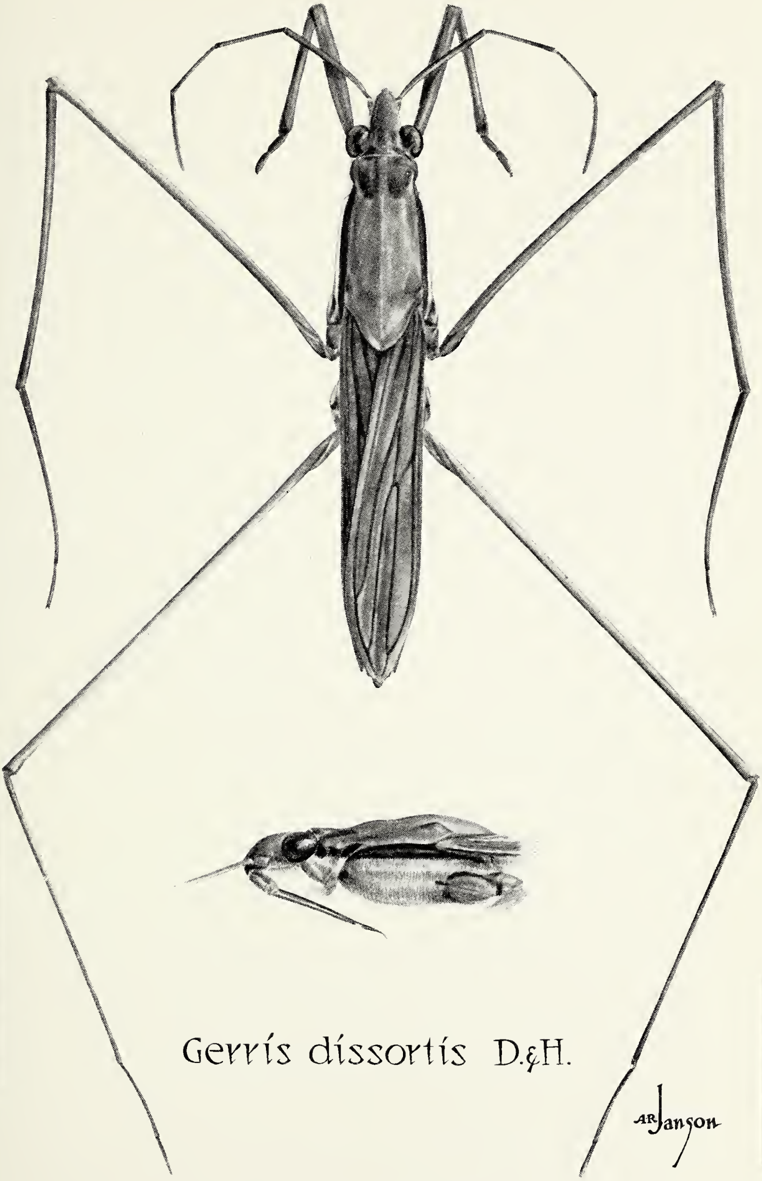
♀. Shorter and plumper than male. Connexiva overlapping lateral margins of last tergite and produced into long, finger-like, somewhat incurved processes that surpass the genital segments by nearly half their length. Genital segments much as in *tridentatus.* The V-shaped incision of the posterior margin of the last venter cutting about half the length of that segment.

Size: 9.00-11.90 mm.

Types from Tena and Mera, Ecuador, University of Kansas. The above notes are taken from the original description.

PLATE XXI

Gerris dissortis Drake and Harris, dorsal and lateral aspect.

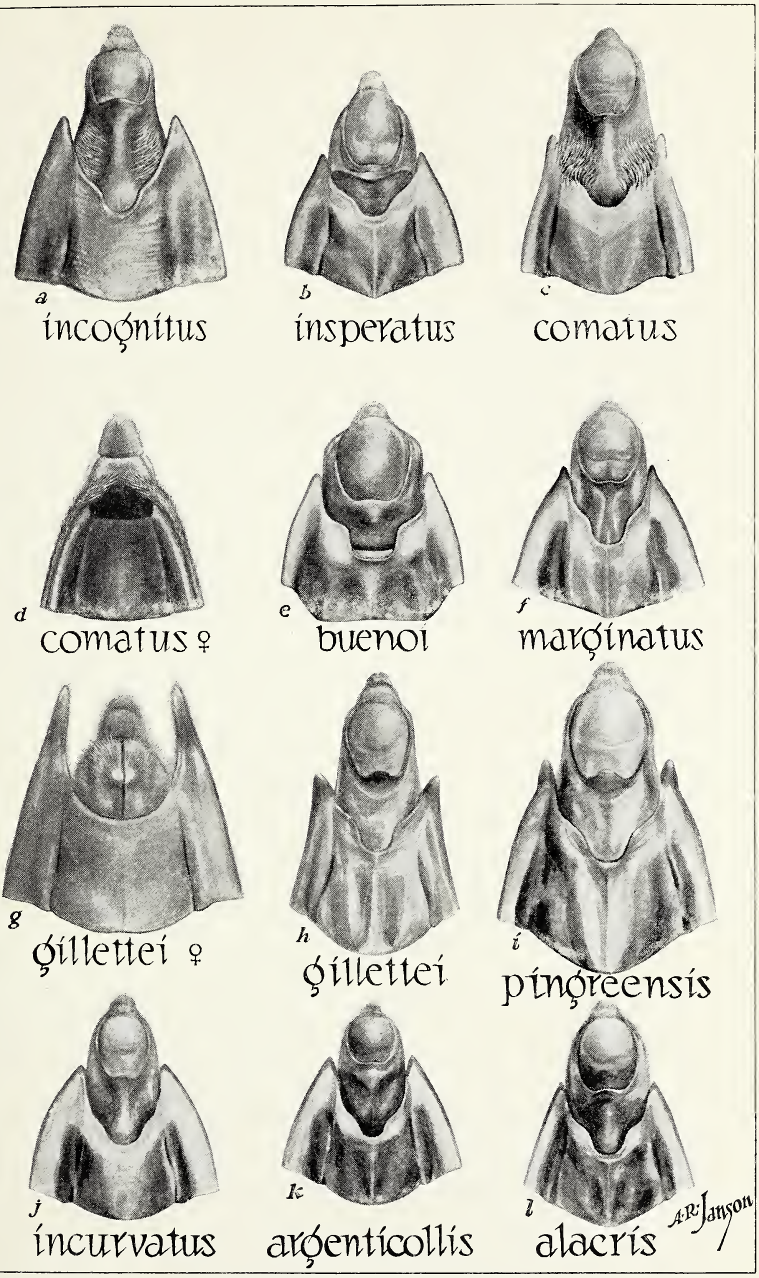


Gerris dissortis D.&H.

For explanation see opposite page.

PLATE XXII

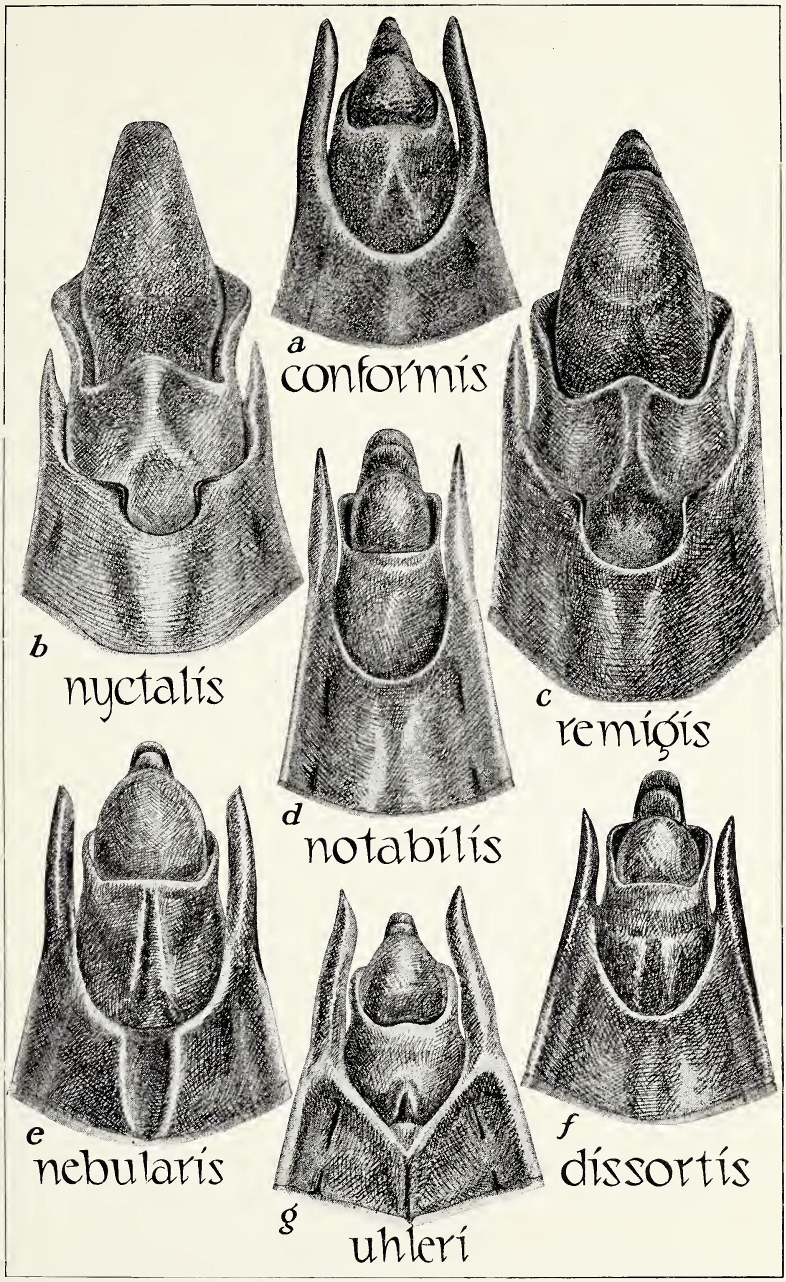
a. *Gerris incognitus* D. & H., ♂.
b. *G. insperatus* D. & H., ♂.
c. *G. comatus* D. & H., ♂.
d. *G. comatus* D. & H., ♀.
e. *G. buenoi* Kirk., ♂.
f. *G. marginatus* Say, ♂.
g. *G. gillettei* L. & S., ♀.
h. *G. gillettei* L. & S., ♂.
i. *G. pingreensis* D. & H., ♂.
j. *G. incurvatus* D. & H., ♂.
k. *G. argenticollis* Parsh., ♂.
l. *G. alacris* Hussey, ♂.



For explanation see opposite page.

PLATE XXIII

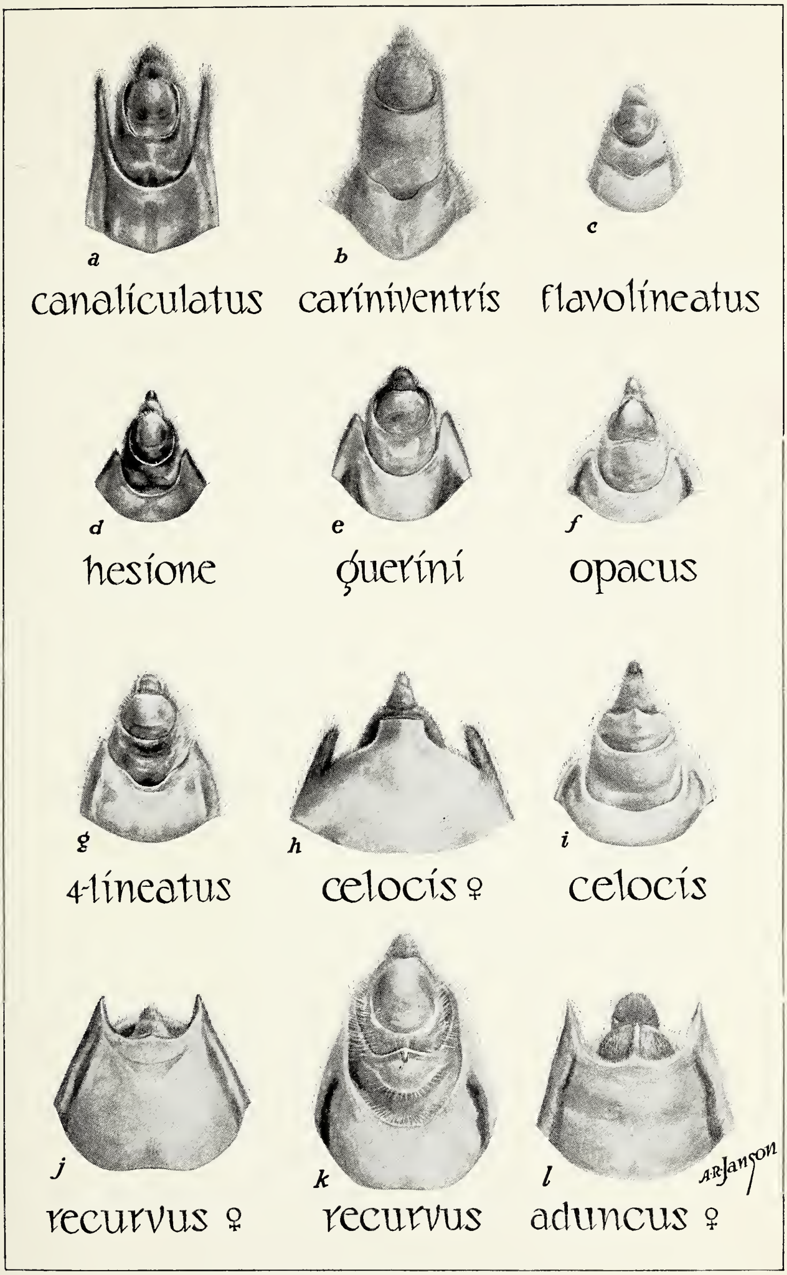
a. *G. conformis* Uhl., ♂.
b. *G. nyctalis* D. & H., ♂.
c. *G. remigis* Say, ♂.
d. *G. notabilis* D. & H., ♂.
e. *G. nebularis* D. & H., ♂.
f. *G. dissortis* D. & H., ♂.
g. *G. uhleri* D. & H., ♂.



For explanation see opposite page.

PLATE XXIV

a. *Gerris canaliculatus* Say, ♂.
b. *G. carniventris* Champ., ♂.
c. *G. flavolineatus* Champ., ♂.
d. *Limnogonus hesione* (Kirk.), ♂.
e. *L. guerini* (L. & S.), ♂.
f. *Tenagogonus opacus* (Champ.), ♂.
g. *T. quadrilineatus* (Champ.), ♂.
h. *T. celocis* D. & H., ♀.
i. *T. celocis* D. & H., ♂.
j. *Limnogonus recurvus* D. & H., ♀.
k. *L. recurvus* D. & H., ♂.
l. *L. aduncus* D. & H., ♀.

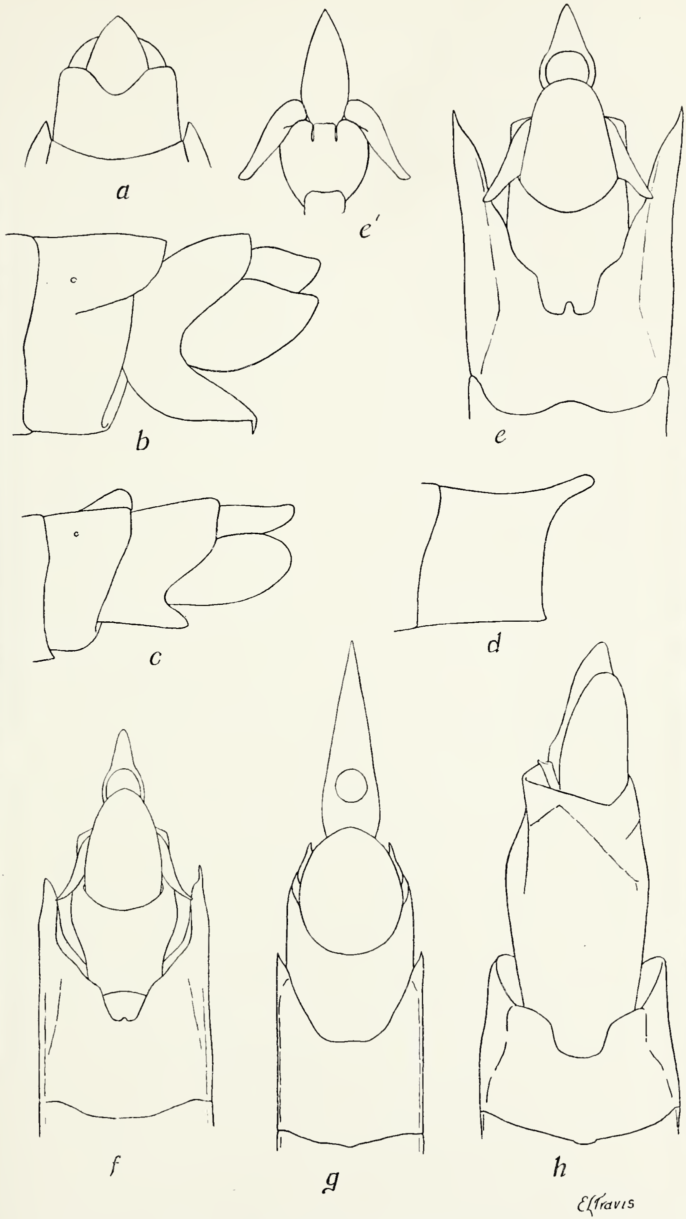


For explanation see opposite page.

PLATE XXV

a. *Limnogonus celeris* D. & H., ♂, dorsal aspect.
b. *L. hyalinus* (Fabr.), ♂, lateral aspect.
c. *L. recens* D. & H., ♂, lateral aspect.
d. *Gerris carmelus* D. & H., ♀, lateral aspect of last abdominal segment.
e. *Cylindrostethus erythropus* (H.-S.), ♂, ventral aspect.
é. *C. erythropus* (H.-S.), ♂, last genital segment, dorsal aspect.
f. *C. linearis* (Erichson), ♂, ventral aspect.
g. *C. regulus* (White), ♂, ventral aspect.
h. *Potamobates osborni* D. & H., ♂, ventral aspect.

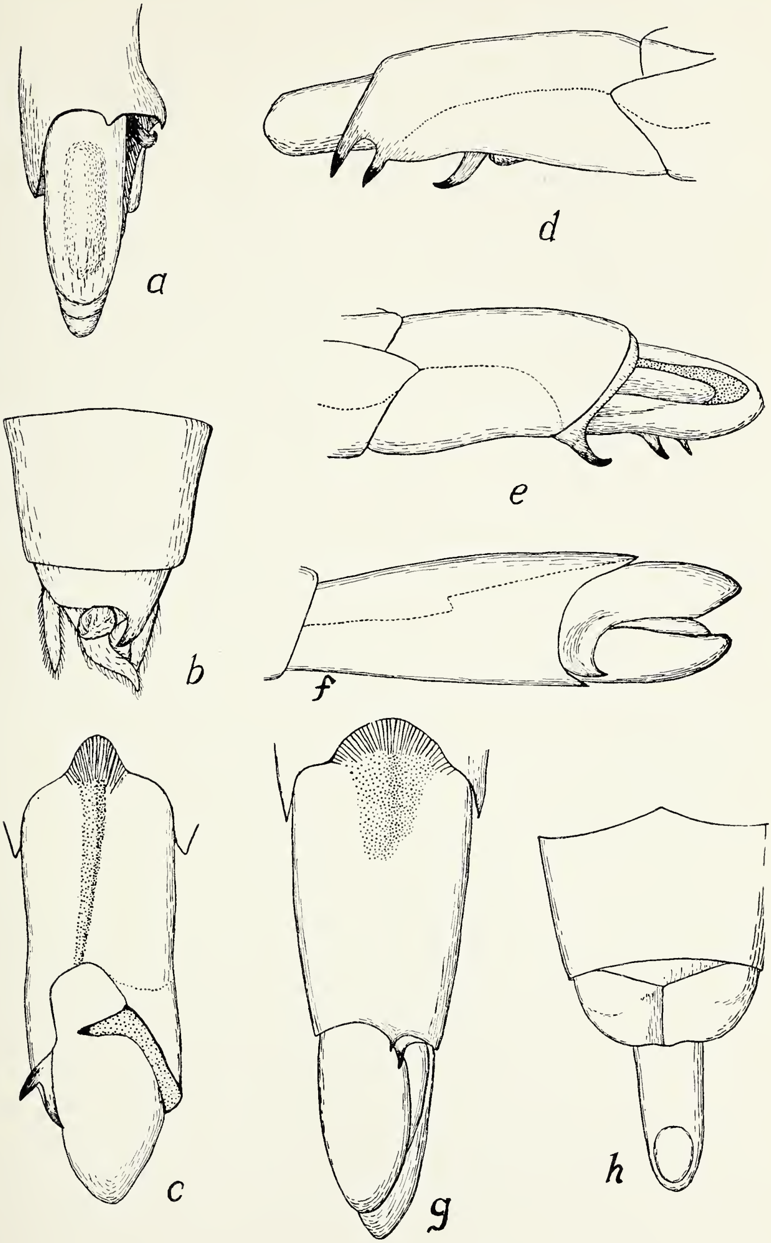
Plate XXV.



For explanation see opposite page.

PLATE XXVI

a. *Potamobates bidentatus* Champ., ♂, ventral aspect.
b. *P. tridentatus* Esaki, ♀, ventral aspect.
c. *P. tridentatus* Esaki, ♂, ventral aspect.
d. *P. tridentatus* Esaki, ♂, lateral aspect.
e. *P. tridentatus* Esaki, ♂, lateral aspect.
f. *P. horvathi* Esaki, ♂, lateral aspect.
g. *P. horvathi* Esaki, ♂, ventral aspect.
h. *P. horvathi* Esaki, ♀, ventral aspect.



For explanation see opposite page.

IV. A SYSTEMATIC STUDY OF A COLLECTION OF MAMMALS FROM SOUTHERN ARIZONA.

By J. Kenneth Doutt

INTRODUCTION

The present paper is a report on a collection of mammals made by the author as a member of the Carnegie Museum Expedition to Arizona in 1927. The purpose of the report is to present a list of the mammals collected or observed, with notes on their life histories, range, and systematic status. An attempt has been made to assemble the pertinent literature dealing with these species in southeastern Arizona.

During the study, the large collection of mammals in the Museum of Vertebrate Zoology at Berkeley, California, was constantly used. Occasional use was made of the collection at the California Academy of Sciences at San Francisco.

The illustrations, unless otherwise indicated, are from photographs by the author.

I am much indebted to Dr. A. Avinoff, Director of the Carnegie Museum, and Dr. O. E. Jennings, Curator of Botany, for making the trip possible; to Dr. Forest Shreve, who so willingly rendered assistance and advice during our work in the field, and who also gave me permission to use part of his work on the Santa Catalina Mountains (Shreve 1915) in connection with the vegetational areas here discussed; to Dr. Joseph Grinnell and Dr. E. Raymond Hall, for their helpful criticism and guidance during the preparation of this report; and to my companions in the field, without whose warm friendship this trip, and many others, would have been much less profitable and enjoyable.

ITINERARY

The collection here reported upon was made between June 28 and August 31, 1927. Headquarters were established at Tucson, and collecting activities, with one exception, were confined to a radius of forty miles from that city.

Issued August 4, 1934.

The party at first consisted of Mr. E. H. Graham and Mr. H. W. Graham, botanists, and the author. Later, Mr. and Mrs. Ottmar Fuehrer and Mr. Ludwig Fuehrer joined the party for a few weeks to gather material for a plant habitat group to be erected in the Carnegie Museum.

Mammal collections were made at the following localities.

1. Base of Quinlin Mountains, forty miles southwest of Tucson, Pima County; between Upper Bajada and Lower Desert Slopes. (The names capitalized are of vegetational areas concerned—*See* p. 245.) June 28 and 29.

2. Florida Canyon (marked as Stone Cabin Canyon on U. S. G. S. topographic map, Arizona, Patagonia quadrangle, edition of 1905, reprint 1920), Santa Rita Mountains, Pima County; Upper Bajada and in small canyon of the Upper Desert Slopes. July 6-11.

3. Near Old Baldy Peak, 8450 feet, Santa Rita Mountains, Santa Cruz County; Fir Forest. July 13 and 14.

4. Peppersauce Canyon, 3000 feet, Santa Catalina Mountains, Pinal County; between Upper Bajada and Lower Desert Slopes. July 21.

5. Sonoran Desert, 1500 feet, 10 miles south of Florence, Pinal County; Lower Bajada. July 26.

6. Pinal Peak, 7800 feet, Pinal Mountains, near Globe, Gila County; Pine Forest. July 29.

7. Sonoran Desert, 1500 feet, 10 miles north of Florence, Pinal County; Lower Bajada. July 29.

8. Vicinity of Desert Laboratory, Tumamoc Hill, 2600 feet, near Tucson, Pima County; between Upper Bajada and Lower Desert Slopes. August 2, 16, and 19.

9. Mouth of Soldier Canyon, 3000 feet, Pima County; Desert Canyon and Upper Bajada. August 4-7, and 11.

10. Cat Mountain, 2600 feet, Tucson Mountains, Pima County; Upper Bajada. August 9.

11. Tucson, 2400 feet, Pima County. August 10.

12. Near Bear Canyon, 3400 feet, Tortolita Mountains, Pima County; Lower Desert Slopes. August 15.

13. Three miles northwest of Tucson, 2300 feet, Pima County; between Lower and Upper Bajada. August 15.

14. Near Soldier Camp, 8000 feet, Santa Catalina Mountains, Pima County; Pine and Fir Forest. August 17, 24-31.

15. Near Walnut, 3300 feet, 22 miles north of Tucson, base of Santa Catalina Mountains, Pinal County; Upper Bajada. August 17.

16. Near Oracle, 4600 feet, north base of Santa Catalina Mountains, Pinal County; Upper Bajada. August 20.

17. Near Stratton Mine, 4600 feet, north slope of Santa Catalina Mountains, Pima County; Lower Encinal. August 30.

GEOGRAPHY AND CHOROGRAPHY OF THE REGION

Southeastern Arizona presents three distinct geographic areas. To the north is the Grand Canyon Section of the Colorado Plateaus Province (see Fenneman, 1930), which consists of a series of high block plateaus trenched by the Grand Canyon. Above these plateaus rise several high mountains, such as the San Francisco Mountain and the White Mountains. Just south of this section is the Mexican Highland section of the Basin and Range Province, a narrow strip of country extending diagonally across the central part of the state from southern Nevada on the north to Mexico and New Mexico on the south and east. It is made up of isolated ranges, which are mainly dissected block mountains, separated by aggraded desert plains. South and west of this section lies the Sonoran Desert, a broad, level plain studded with low, short mountain ranges, and gradually sloping from an altitude of 3000 to 4000 feet at its northeast border along the Mexican Highland, to sea level at the Gulf of California. The division between the Mexican Highland and the Sonoran Desert passes just east of Tucson, along the west bases of the Santa Catalina and Santa Rita mountains. Thus the major portion of the collecting was done along the border between these two provinces.

These physiographic areas have an important effect on the flora and the fauna of the region. The forms found on the mountain tops are most closely related to species which occur farther to the north, while the forms found on the desert are representatives of southern species. The northern species range southward over the high mountains and plateaus, and find their southern limits on the mountains of the Mexican Highland, which project, like peninsulas, into a sea of desert plains. Erosion has separated certain of these mountains more or less effectively from the main mountain mass, so that they now rise, like islands, from the desert plain, and harbor isolated boreal forms. The desert-dwelling types reach their greatest elevation in the canyons, where the effect of altitude is felt most gradually.

Physiographically, the Santa Catalina, Santa Rita, and Huachuca mountains belong to the Mexican Highland Section, but they are separated from the other mountains of the series by the Gila and the San Pedro rivers, so that they are more closely connected with the Mexican Cordillera than with the Rocky Mountains. Although this separation has not produced any great differences in the flora and the fauna, minor differences do occur. In a more striking manner, the Gila and Salt rivers form a barrier to boreal forms across the Mexican Highland Section. In several cases, there are noticeable differences between species occurring to the north and south of these rivers. In some cases, these differences are sufficient to be recognized subspecifically. For example, specimens of *Otospermophilus grammurus grammurus*, *Peromyscus maniculatus rufinus*, and *Sciurus arizonensis arizonensis*, occurring to the north, are more rufous in color than specimens to the south of this barrier. In the case of *Sciurus arizonensis*, the difference is sufficient to warrant the recognition of the subspecies *catalinæ* to the south, and further study may prove that specimens of *P. m. rufinus* from south of the Gila and Salt rivers should also be recognized as a separate subspecies. The difference in specimens of *Otospermophilus* is likewise noteworthy, although perhaps not sufficient for subspecific rank. In a similar manner, this barrier forms the dividing line between *Junco phæonotus palliatus*, occurring to the south, and *J. p. dorsalis*, occurring to the north.

Thus it is demonstrated, not only by our own observation, but by that of other naturalists who have worked in the region, that these geographic areas coincide with faunal and floral areas. Clements (1920, p. 171), Livingston and Shreve (1921, pp. 32-36), and Swarth (1928, pp. 269-283), all show a striking similarity in their definitions of the boundaries of this faunal and floral area. Mearns (1907, p. 74 and map pl. 2) also recognizes a faunal area in this vicinity, but he draws the boundary line about a hundred miles to the east, at the New Mexico-Arizona line.

VEGETATION OF THE REGION

The life zone concept as originally presented by Merriam was excellent, but many recent authors have found it desirable to subdivide, more minutely, the area under consideration. For example, see Mearns (1907, pp. 70-75); Grinnell (1914, pp. 62-96); Shreve

(1915, pp. 11-36); Clements (1920, pp. 172-177); Livingston and Shreve (1921, pp. 32-36); Swarth (1929, pp. 269-283).

The most thorough and accurate study of the vegetation of southeastern Arizona has been made by Shreve (1915). Although his discussion is limited to the Santa Catalina Mountains, it is applicable, with very slight additions, to the entire region in which collections were made; it is, therefore, used in the following discussion of the vegetation.

The desert plain, which surrounds the base of all the mountains in this region, extends from the Mexican Highland to the Gulf of California, and carries with it a characteristic flora and fauna. Greater changes in vegetation occur between the bases and the tops of such mountains as the Santa Rita and the Santa Catalina than in the entire distance between Tucson and the Gulf of California. These changes become more rapid as the steepness of the slope increases, and on such mountains as mentioned above, very definite floral areas occur. Shreve divides the vegetation into three main regions, the Desert, the Encinal, and the Forest. These regions are further subdivided as follows:

DESERT REGION

- Lower Bajada
- Upper Bajada
- Desert Arroyos and Canyons
- Lower Desert Slopes
- Upper Desert Slopes

ENCINAL REGION

- Lower Encinal
- Upper Encinal

FOREST REGION

- Pine Forest
- Fir Forest

The Desert Region is roughly comparable to the Lower Sonoran of Merriam, the Encinal to the Upper Sonoran, the Pine Forest to the Transition, and the Fir Forest to the Canadian.

DESERT REGION

LOWER BAJADA

The Lower Bajada is found on the lowest desert plains. The soil here is frequently alkaline, and the vegetation is much restricted in its variety of forms. The most characteristic plant is *Larrea tridentata* (Creosote Bush), and often this is the only plant occurring over wide areas. Other plants which enter this community are *Prosopis velutina* and several species of *Opuntia* (Prickly Pear).

UPPER BAJADA

The Upper Bajada consists of desert plains at slightly higher elevations than the Lower Bajada, and thus they are freer from the alkali which so reduces the vegetation of the latter region. Vegetation here is characterized by lowness of stature, openness of stand, and variety of species. Cactuses attain their maximum development in the Upper Bajada, both as to size and to variety of form. One of the most striking plants of this association is *Carnegiea gigantea* (Sahuarro or Giant Cactus), which finds its optimum habitat in the vicinity of the Santa Catalina Mountains. Other characteristic plants are *Prosopis velutina* (Mesquite), *Parkinsonia microphylla* (Palo Verde), *Fouquieria splendens* (Ocotillo), *Ferocactus wislizeni* (Barrel Cactus), *Simmondsia californica* (Jajobe), several species of *Opuntia* (Prickly Pear), and *Acacia greggii* (Cat Claw).

DESERT ARROYOS AND CANYONS

Desert Arroyos and Canyons vary in size from shallow drainageways, through which water runs for only a few hours after the severe summer rains, to large canyons or valleys through which a flow of water is constant. The smaller arroyos have no characteristic flora, but usually such plants as *Prosopis velutina* (Mesquite), *Acacia greggii* (Cat Claw), and *Mimosa pallida* grow more abundantly and more luxuriously along their borders. In arroyos large enough to have a heavy flow of storm water, there are, in addition, a number of characteristic species, such as *Parkinsonia torreyana*, *Celtis reticulata* (Western Hackberry), *Baccharis sarothroides* (Batamote), and *Chilopsis linearis*

(Desert Willow). In the largest canyons, where there is a flow of water for all or a large part of the year, mesophilous, palustrine, and even purely aquatic plants are found, in addition to the species found in the smaller arroyos. A few of these are *Populus* sp., *Fraxinus toumeyi* (Ash), *Juglans major*, *Platanus wrightii* (Sycamore), *Sapindus saponaria*, *Sambucus mexicana*, *Salix wrightii*, and three species of *Quercus*.

LOWER DESERT SLOPES

The Upper Bajada passes gradually into the Lower Desert Slopes. The physical conditions which characterize these slopes are pronounced slope exposure, large masses of rock *in situ*, and coarse soil limited to small benches, pockets, or fissures. The vegetation is similar to that of the Upper Bajada. *Prosopis*, *Parkinsonia*, and *Acacia* are represented by smaller and less frequent individuals, while *Carnegiea gigantea* is more abundant but consists of smaller individuals. *Fouquieria*, *Encelia*, and *Chrysoma laricifolia* are more abundant than on the Upper Bajada, and here are found for the first time *Vauquelinia californica*, *Agave palmeri*, and *Dasylirion wheeleri* (Sotol).

The elevation of the different vegetational regions varies with the different mountains, as well as with different exposures on the same mountain. On the southern side of the Santa Catalinas, the Lower Desert Slopes usually lie between 3000 and 4000 feet, while the Upper Desert Slopes reach 5000 feet.

UPPER DESERT SLOPES

The Upper Desert Slopes are made distinctive by the entrance of certain plants of striking form, by the disappearance of the desert species, and by an abundance of perennial grasses, root perennials, small shrubs, and ephemeral plants, all of which help to form a much more complete ground-cover than is found on any parts of the Bajada. On these Upper Desert Slopes, *Vauquelinia* and *Dasylirion* are common, and occur along with *Nolina microcarpa* (Bear Grass), *Arctostaphylos pungens* (Manzanita), *Agave schottii*, and *Yucca macracarpa*. Other species include *Bouteloua rothrockii* (Grama Grass), *Muhlenbergia dumosa*, *Andropogon scoparium* (Beard Grass), *Eriogonum wrightii* (Umbrella Plant), *Dalea wislizeni*, and *Asclepias linifolia* (Milkweed).

ENCINAL REGION

Some of the characteristic plants of the Encinal Region are found as low as 4000 feet, while others go as high as 8000 to 8600 feet into the Forest Region. However, in general, the Lower Encinal may be said to begin at about 5000 feet on the south slopes of the mountains, and on the same side of the mountains, the Upper Encinal begins at about 5800 feet, and ends between 6200 and 6400 feet, where the Pine Forest starts.

LOWER ENCINAL

Open orchard-like stands of *Quercus oblongifolia* and *Quercus arizonica* mark the beginning of the Lower Encinal. Other common species at its desert edge are *Juniperus*, *Vauquelinia*, *Dasylirion*, *Nolina*, *Yucca macrocarpa*, and *Agave palmeri*, all of which become more abundant farther up the mountains. The following plants appear only in the higher parts: *Quercus emoryi*, *Pinus cembroides* (Mexican Pinyon), *Garrya wrightii* (Silk Tassel), *Rhus trilobata* (Squaw Bush), and *Rhamnus crocea* (Red-berry).

UPPER ENCINAL

The chief difference between the Upper and the Lower Encinal is the gradual increase in density of stand of the evergreen trees and shrubs. True Upper Encinal is a dense thicket of trees 18 to 30 feet high. *Quercus emoryi* and *Quercus arizonica* are still the dominant trees, and the most common shrubs are *Arctostaphylos pungens*, *Garrya wrightii*, and *Mimosa biuncifera*. Semi-desert species and cactuses are infrequent. In places, *Pinus cembroides* forms almost pure stands, and here appear the first individuals of *Quercus reticulata*, *Pinus chihuahuana* (Chihuahua Pine), and *Arbutus arizonica*.

FOREST REGION

PINE FOREST

The transition from Upper Encinal to Pine Forest is one of the most striking changes on the mountains. In the Santa Catalinas, it occurs between 5800 and 6000 feet on north slopes, and 6000 to 6400 feet on south slopes. Here the dense oak thickets give way to open forests of

Pinus arizonica (Arizona Yellow Pine), which attains a height of fifty to sixty feet. Throughout the Pine Forest, certain species occur which are also present in the Encinal, but it is only on the lowest edge of the Pine Forest that any genera characteristic of the Desert Region are found. The three to be noted are *Echinocereus polycanthos* (Hedgehog Cereus), *Yucca*, and an *Agave.* Characteristic trees are *Arbutus arizonica*, *Pseudotsuga mucronata* (Douglas Fir), *Pinus strobiformis* (Mexican White Pine), *Juglans rupestris*, *Prunus virens*, *Acer interior*, and *Alnus acuminata.* Some of the most conspicuous plants of the forest floor are *Ceanothus fendleri*, *Muhlenbergia virescens* (Bunch Grass), *Houstonia wrightii*, *Erigeron neomexicanus*, *Pteris aquilina* (Brake Fern), *Castilleja gloriosa*, and *Solidago bigelovii* (Golden Rod).

FIR FOREST

The transition from Pine to Fir Forest is not as abrupt or evident as that from the Upper Encinal to the Pine Forest. Nevertheless, the Fir Forest is found on all mountains which reach sufficient altitude. On the Santa Catalinas, this altitude is about 7500 feet on north slopes, but these mountains are not of sufficient height to bring the Fir Forest on southern exposures. The first indicators are the increasing numbers of *Pseudotsuga mucronata* and *Pinus strobiformis*, and the appearance of *Abies concolor* (White Fir). *Pinus arizonica* becomes more and more infrequent, and *Pinus strobiformis* is no longer confined to streams, but becomes mingled with *Pseudotsuga* and *Abies.* In the Fir Forest, the last relics of the Encinal have disappeared. *Quercus submollis* and *Populus tremuloides* are the most common subordinate trees, and frequently become dominant over areas of an acre or more in extent. Dense shade, heavy litter, and high humus content of the soil are characteristic conditions of the forest floor. These conditions are much different from those of the floors of any of the lower regions, and they combine to produce a very different type of undergrowth. In the densest stands, shrubs and herbaceous plants are not as abundant as in the Pine Forest. However, along streams, on open flood plains, and on dry ridges, slightly different environments occur, which bring variety into the Fir Forest. A few of the characteristic species are *Jamesia americana*, *Symphoricarpos oreophilus*, *Ribes pinetorum*, *Alnus acuminata*, *Acer interior*, *Salix exigua*, *Hypericum formosum*, *Osmorrhiza nuda*, *Oxalis metcalfii*, and *Galium asperrimum.*

CHECK-LIST OF MAMMALS TREATED IN THIS REPORT*

1. Sorex vagrans monticola Merriam
2. Nycteris borealis teliotis (H. Allen)
3. Spilogale gracilis gracilis Merriam
4. Mephitis estor Merriam
5. Taxidea taxus berlandieri (Baird)
6. Otospermophilus grammurus grammurus (Say)
7. Citellus tereticaudus neglectus (Merriam)
8. Ammospermophilus harrisii harrisii (Audubon and Bachman)
9. Eutamias dorsalis dorsalis (Baird)
10. Sciurus arizonensis catalinæ Doutt
11. Thomomys fulvus intermedius Mearns
12. Perognathus baileyi baileyi Merriam
13. Perognathus penicillatus pricei (Allen)
14. Dipodomys spectabilis spectabilis Merriam
15. Dipodomys merriami merriami Mearns
16. Peromyscus maniculatus rufinus (Merriam)
17. Peromyscus boylei rowleyi (Allen)
18. Neotoma albigula albigula Hartley
19. Neotoma mexicana bullata Merriam
20. Neotoma lepida stephensi (Goldman)
21. Erethizon epixanthum couesi Mearns
22. Lepus alleni alleni Mearns
23. Lepus californicus eremicus (Allen)
24. Sylvilagus audubonii arizonæ (Allen)
25. Pecari angulatus sonoriensis (Mearns)

MAMMALS OBSERVED OR REPORTED BUT OF WHICH NO SPECIMENS WERE OBTAINED

26. Kit Fox: Vulpes macrotis neomexicana Merriam
27. Coyote: Canis mearnsi Merriam
28. Mountain Lion: Felis concolor azteca (Merriam)
29. Deer: Odocoileus couesi (Coues and Yarrow)

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*Since this paper was written, articles dealing with the mammals of the region have been published by W. H. Burt; E. R. Hall; L. M. Huey; and E. A. Goldman.

PLAN OF TREATMENT

In the following list, an account is presented of each species of mammal collected. The scientific name is given first, and then an accepted common name. Following this, reference is made to the various accounts which deal with the species in southeastern Arizona. For convenience, reference is also made to Miller's list (Miller, 1924). The statement of material is restricted to those specimens collected by the author.

In the itinerary, each locality at which collections were made is listed, and is followed by a statement as to the vegetational area (life zone) in which it is located. Thus the vegetational region in which any specimen was taken can be determined by referring to the given locality in the itinerary.

ANNOTATED LIST OF THE MAMMALS COLLECTED

1. **Sorex vagrans monticola** Merriam

ROCKY MOUNTAIN SHREW

Sorex vagrans monticola, Miller (1924, p. 20); Jackson (1928, p. 110).

Material.—1 ad. female, Aug. 31, near Soldier Camp, Santa Catalina Mountains.

Remarks.—The single specimen of *Sorex* was caught near the edge of a small reservoir only after the *Peromyscus* had been reduced in numbers.

2. **Nycteris borealis teliotis** (H. Allen)

WESTERN RED BAT

Lasiurus borealis teliotis, Miller (1897, p. 110).
Nycteris borealis teliotis, H. W. Grinnell (1918, p. 323); Miller (1924, p. 79).

Material.—4 specimens: 1 ad. female, 1 im. male, 2 im. females, Aug. 10, Tucson.

Remarks.—The ranges of *N. b. teliotis* and *N. b. borealis* might be expected to meet somewhere in the vicinity of Tucson. The single adult female from Tucson is not typical of either race. Allen lists an adult female (subspecies undetermined) with two nursing young from the Chiricahua Mountains, 95 miles southeast of Tucson (see *Atalapha borealis*, Allen, 1895, p. 246). The present specimens and also those listed by Allen were roosting in a peach tree.

3. **Spilogale gracilis gracilis** Merriam

CANYON SPOTTED SKUNK

Spilogale gracilis, Allen (1895, p. 252); Howell (1906, p. 22).
Spilogale gracilis gracilis, Miller (1924, p. 133).

Material.—7 specimens: 1 ad. female nursing, July 8, Florida Canyon, Santa Rita Mountains; 1 ad. male and 2 im. females, Aug. 5 and 6, mouth of Soldier Canyon, Santa Catalina Mountains; 1 ad. male and 1 im. female, Aug. 29 and 30, near Soldier Camp, Santa Catalina Mountains; 1 im. male, Aug. 30, near Stratton Mine, Santa Catalina Mountains.

Remarks.—These specimens were identified by Dr. A. H. Howell. We found the species ranging from Upper Bajada at 3000 feet to Fir Forest at 8000 feet, or a total altitudinal range of 5000 feet. They were very common both at Soldier Canyon and at Soldier Camp.

It was so late when we found a camping spot in Florida Canyon that we had to make camp at once, so I strung, on a line outside the tent, three Jack Rabbits I had collected. Under them, I set three steel traps, which were not fastened. The next morning one of the traps was gone, but shortly the clink of the trap chain against a rock led me to the place where an adult female spotted skunk was hiding. By careful manipulation, it was possible to drain out all the contents from the scent glands, and after that the animal was practically harmless. It was kept about camp for several days, and although it did not become tame, we were able to approach without causing it to assume the normal defense attitude. In fact, with care we were able to handle and pet the skunk.

4. **Mephitis estor** Merriam

ARIZONA SKUNK

Chincha estor, Howell (1901, p. 32).
Mephitis estor, Allen (1895, p. 250); Grinnell (1914, p. 257); Swarth (1929, p. 347).

Material.—3 specimens: 1 im. male, July 29, Pinal Peak, Pinal Mountains; 1 im. female, and 1 skull only, Aug. 27, near Soldier Camp, Santa Catalina Mountains.

Remarks.—*Mephitis* and *Spilogale* were both found in the vicinity of Soldier Camp. *Spilogale* occurred both on the tops of the mountains and at the mouths of canyons near the desert floor. *Mephitis*, however, was collected only on the tops of the mountains.

The female taken near Soldier Camp was caught in a steel trap. When I approached it, it made no attempt at defense, merely looked up, took notice of me, and then huddled down over the trap again. I was able to approach within a few feet to take a photograph without disturbing it.

5. **Taxidea taxus berlandieri** (Baird)

MEXICAN BADGER

Taxidea taxus berlandieri, Allen (1895, p. 256); Grinnell (1914, p. 259); Miller (1924, p. 142).

Material.—1 im. male, July 21, Peppersauce Canyon, Santa Catalina Mountains.

Comparisons.—Very similar in color to specimens from southern and eastern California, and central Nevada. Specimens from northern and western California are slightly more Tawny Olive.

Remarks.—The specimen is of a young male about half grown. When first observed, it was walking leisurely down a ditch beside the road, apparently unaware of the approach of a noisy automobile. When pursued, it attempted to escape, but was easily overtaken. As soon as it saw that it could not evade me, it turned, and with ferocity, assumed an offensive attitude; only after some difficulty was it captured and put into a wooden box. This, however, proved to be a poor cage, for with its long claws and sharp teeth it soon made a hole in it that was almost large enough for escape.

After several days, it became much more docile but never very friendly, and we always touched it with a certain amount of caution. Occasionally it was turned loose in a large field, and invariably it attempted to escape by running away or by digging. If given opportunity, it could bury itself in the ground in a very few minutes. As it dug, an almost continual stream of earth was forced into the air by its hind feet, and by the time the front half of its body was beneath the ground, it was almost impossible to pull it out.

6. **Otospermophilus grammurus grammurus** (Say)

COLORADO ROCK SQUIRREL

Anisonyx (*Otospermophilus*) *grammurus*, Allen (1895, p. 237).

Otospermophilus grammurus, Mearns (1907, p. 315).

Otospermophilus grammurus grammurus, Miller (1924, p. 180); Swarth (1929, p. 348).

Material.—7 specimens: 1 ad. male, July 14, Old Baldy Peak, Santa Rita Mountains; 1 im. female, Aug. 2, 1 ad. male and 1 ad. female, Aug. 16, Desert Laboratory, Tucson; 1 ad. female, Aug. 5, mouth of Soldier Canyon, Santa Catalina Mountains; 2 ad. males, Aug. 25 and 30, near Soldier Camp, Santa Catalina Mountains.

Comparisons.—These specimens differ from the description of *Otospermophilus grammurus* given by Mearns (1907, p. 315) only in the following details:

1. Top of head and ears not much mixed with black.
2. Orbital circle white, not yellowish white.
3. Total length averages 12 to 21 mm. less.

A specimen in the Museum of Vertebrate Zoology collection from northeast of San Francisco Mountain, when compared with specimens from south of the Salt River, shows a darker, more red rump patch. In this respect it is more like a young female from Colorado Springs, Colorado. This latter specimen is nearer to the type locality of *Otospermophilus grammurus grammurus* than any other specimen which I have. Compared with specimens from south of the Salt River, its rump patch is decidedly redder, and it extends farther towards the head; the shoulders are not so gray, but are mixed with a little more brown. In general, specimens from south of the Salt River appear to have a lighter, that is, a more yellow and less red rump patch than specimens to the northward.

Remarks.—Rock Squirrels were found throughout the region in which we collected, wherever suitable habitats occurred. They ranged in altitude from 2400 to 9400 feet. At the lower elevations, they were found in rocky canyons, and on the mountains, in the neighborhood of cliffs and rock piles. Though they were seldom seen in trees, they could readily climb when the occasion demanded it. They were often found in the same habitat as *Spilogale*; a trap set in the same place for two consecutive days caught a Rock Squirrel one day and a Spotted Skunk the next. A young female about half grown was taken on August second, and others of the same size were seen at the time.

The female taken near the mouth of Soldier Canyon was kept alive for two days; it had been caught in a steel trap by one foot but was not seriously injured. When placed in the same cage with a Gila Monster, it immediately showed great fear, and kept as far from the Gila Monster as the cage would permit, frequently uttering a high-pitched jerky whistle. Late the next afternoon, it was found lying unconscious on the floor of the cage. Aromatic spirits of ammonia revived it slightly, but it died that evening. Presumably, a bite from the Gila Monster caused its death; the Gila Monster was unharmed.

7. **Citellus tereticaudus neglectus** (Merriam)
DOLANS SPRING GROUND SQUIRREL

Spermophilus neglectus Merriam (1889, p. 17).
Anisonyx (*Ictidomys*) *tereticaudus*, Allen (1895, p. 238).
Citellus tereticaudus, Mearns (1907, p. 336).
Citellus tereticaudus tereticaudus, Grinnell (1914, p. 224), part.
Citellus tereticaudus arizonæ Grinnell (1918, p. 105).
Citellus neglectus, Miller (1924, p. 189).
Citellus tereticaudus neglectus, Swarth (1929, p. 349).

Material.—7 specimens: 1 ad. female, July 26, 10 mi. south of Florence; 3 ad. males, 3 ad. females, Aug. 5-11, mouth of Soldier Canyon, Santa Catalina Mountains.

Remarks.—*Citellus tereticaudus arizonæ* is synonomized with *Citellus neglectus* for the following reasons: The original description of *neglectus* mentions the two essential features that differentiate *C. neglectus* and *C. t. tereticaudus*. Furthermore, the author makes it clear that *neglectus* is more closely related to the species *tereticaudus* than to any other species. Grinnell (1914, p. 224), in his Colorado River survey, demonstrates that the specimens of *Citellus* from the Arizona side of the river are distinct from those on the California side; thus the subspecies *tereticaudus* is restricted to the California side of the river. Grinnell (1918, pp. 105-106) shows that the specimens of *Citellus tereticaudus* from Arizona are easily distinguishable from *eremonomus*, *chlorus*, and *tereticaudus*, the three known subspecies of *Citellus tereticaudus*. However, he does not mention *neglectus*, which was described from northwestern Arizona. It is clear, therefore, that specimens of *Citellus tereticaudus* from Arizona should be referred either to *arizonæ* or to *neglectus*. Careful comparison of the original descriptions reveals little difference between the two forms. Each author compares the specimens he is describing with *C. t. tereticaudus*. The two most important characters given by each author are color of the upper parts and length of the tail. Both state that the tail is noticeably shorter in Arizona-taken animals than that of *C. t. tereticaudus*. Grinnell, using Ridgway (1912) as a standard for color nomenclature, says of the upper parts: "On back, top of head and tail, deep pinkish cinnamon, becoming paler on neck, shoulders and sides, due to the greater extent of the minute white tippings to the hairs." Merriam describes the color of the upper parts as follows: "Above, grizzled grayish brown, resulting from the intimate and very fine admixture of white and black tipped hairs over a cinnamon ground color." Some time after the description of *arizonæ*, Dr. Grinnell had an opportunity to examine the type of *neglectus*, and he found that it was not distinct from specimens which he had previously called *arizonæ*. Therefore, it must stand as a synonym of *neglectus*, which antedates *arizonæ* by more than a quarter of a century.

In spite of the fact that it is necessary to regard *neglectus* and *arizonæ* as synonyms, there is a great deal of variation in skin measurements of different local groups. For instance, an adult male specimen collected near Tucson, Arizona, measured: total length 248, tail 89, hind foot 37 mm.; five adults from the mouth of Soldier Canyon averaged 240, 80.2, 31.2 mm. (measurements in same order as above); and a specimen from ten miles south of Florence measured 221, 70, 35 mm. This last specimen, though fully adult, and with a perfect tail, was very small both in skin and skull measurements; in color it was more cinnamon than any individual from the mouth of Soldier Canyon. The table given by Mearns (1907, p. 338) shows a gradual increase in tail length as one progresses from the vicinity of Phoenix and New River to the Mexican boundary, and thence westward to the vicinity of Seven Wells, Lower California.

There is an interesting parallel between *Ammospermophilus harrisii harrisii* and this species of *Citellus*. Both are desert rodents with a short summer coat, and in both the skin on the dorsal surface is very heavily pigmented. Other diurnal desert rodents, such as *Lepus californicus eremicus* and *Lepus alleni alleni*, which have a heavy coat of fur throughout the summer, lack the pigment in the skin. Perhaps the pigment is correlated with the slight protection given by the very thin summer coat, and serves to protect the animal from the intense sunlight. It would be interesting to see if such a relation holds in other mammals.

8. **Ammospermophilus harrisii harrisii** (Audubon and Bachman)
HARRIS GROUND SQUIRREL

Anisonyx (*Ammospermophilus*) *harrisii*, Allen (1895, p. 240).
Ammospermophilus harrisii, Mearns (1907, p. 303); Swarth (1929 p. 349).
Ammospermophilus harrisi harrisi, Grinnell (1914, p. 219).
Ammospermophilus harrisii harrisii, Miller (1924, p. 195).

Material.—9 specimens: 4 ad. females, July 6-10, Florida Canyon, Santa Rita Mountains; 1 ad. female, 1 ad. male, 2 skull only, Aug. 4-16, mouth of Soldier Canyon, Santa Catalina Mountains.

Remarks.—Both Grinnell (1914, p. 221) and Swarth (1929, p. 351) state that specimens of *Ammospermophilus* from the east side of the Colorado River do not bear out Mearns' (1896, p. 444, and 1907, p. 306) description of *A. h. saxicola*, and they discard the latter name as synonymous with *harrisii*. However, I believe *saxicola* will bear further consideration. During this study, only one topotype of *saxicola* was available. Although probably mature, it is a young individual. Little difference can be detected in color between it and specimens of *harrisii* in the Museum of Vertebrate Zoology collection from the east side of the Colorado River. However, two individuals of *harrisii* from the Colorado River which were comparable in age with the specimen of *saxicola* have a tail to body ratio of 54 and 48.3 respectively, and one specimen of *harrisii* from the vicinity of Tucson has a tail to body ratio of 52.4, while the specimen from Tinajas Altas, the type locality of *saxicola*, has a tail to body ratio of 57.5. Of the available specimens of *harrisii*, these three are most similar to the specimen of *saxicola* in the above measurements. Young individuals have a much greater tail to body ratio than old individuals from the same locality, and so the above specimens were selected because they were of comparable age. In the table of measurements given by Mearns (1907, pp. 307-309), thirty-two specimens of *A. h. harrisii* have an average total length of 235 and a tail length of 80.3, which makes a tail to body ratio of 52; fifteen specimens of *A. h. saxicola* have an average total length of 234 and tail length of 86.6, which makes a tail to body ratio of 59. *Saxicola* also shows slight differences in skull measurements as indicated in the following table:

TABLE I

	Occipito-nasal length	Zygomatic width
Topotype of *saxicola*	36.5	21.1
Specimen from E. side Colorado River	38.3	22
Specimen from Tucson	40.3	23

Again these individuals were selected because they were of comparable age; they also proved to approach *saxicola* most closely in these measurements. The average measurements given by Grinnell (1914, p. 220) for twenty-four adults from the Arizona side of the Colorado

River, followed in parenthesis by the average of five adults from Florida Canyon and the mouth of Soldier Canyon are as follows: occipito-nasal length of skull 39.3 (40.7); zygomatic width 22.7 (23.2).

Specimens from the Colorado River region should not be taken to represent *saxicola*, for although Mearns (1907, p. 303) says, "In the desert ranges bordering the lower Colorado River it [*Ammospermophilus harrisii*] is represented by the subspecies *saxicola*," this is not a clear statement of his idea of its range as is indicated on page 306 (*op. cit.*), where he defines its range more accurately as follows: "This [*Ammospermophilus harrisii saxicola*] is a long-tailed, pallid, desert race, inhabiting bare granite ranges of mountains, extending in a southeasterly direction from the Gila River, in southwestern Arizona (Yuma County), into western Sonora." From the first statement, one would be led to believe that *saxicola* is to be found along the Colorado River, but as he defines the range of this subspecies, it does not reach the Colorado River at all, and further, on page 307 (*op. cit.*) he says, "none were observed along the lower course of the Colorado River." It therefore appears that *saxicola* occurs *south* of the Gila River and ranges in a north-south rather than in an east-west direction. Thus specimens from the Colorado River would not represent *saxicola*, and I believe more topotypes should be examined before the subspecies is discarded.

Ammospermophilus harrisii harrisii presents some interesting problems in geographic distribution. Mearns (1907, p. 303) says that Arizona is its center of abundance, but that it extends into California, Nevada, Utah, New Mexico, and Mexico. From Grinnell's Colorado River survey (Grinnell, 1914), however, it is evident that *A. h. harrisii* is restricted to the Arizona side of the lower Colorado River, and thus does not extend into California. Mearns (1907, p. 304) has recorded specimens of *A. h. harrisii* from "the deep canyon of the Colorado" and the tributary canyon of Cataract Creek, which is a branch of Havasu Creek. This latter locality lies between the type localities of *A. leucurus cinnamomeus* and that of *A. l. tersus*, recently described by Goldman (1929, p. 435) from the lower end of Prospect Valley, Grand Canyon, Hualpai Indian Reservation, 4500 feet. This small colony of *harrisii* would thus appear to be surrounded by *leucurus*, or else *harrisii* ranges over the northern part of the Coconino Plateau at a greater elevation than 6000 feet, which I believe is almost 800 to 1000 feet higher than it is known to occur. Mearns (1907, p. 303) gives its limit as being below 5200 feet. Further examination of this colony of *harrisii* should prove very interesting. I have no record of *A. h. harrisii* from north of the Magollon Plateau nor anywhere above the 6000 foot contour line extending northward to the Colorado River. Thus *harrisii* in Arizona seems to be confined south and west of this 6000 foot contour line, which extends roughly from Clifton in the southeast section of the state to Grand Wash Cliffs in the northwest part of the state. Further, both Swarth (1929, p. 349) and Mearns (1907, p. 305) comment on the absence of *harrisii* in the extreme southeastern section of the state, from the Pajaritos and Santa Rita mountains eastward. Between Ft. Bowie and the Mogollon Plateau, however, Swarth (*loc. cit.*) states that it extends into New Mexico.

One individual of *A. h. harrisii* was seen feeding at a pile of horse dung. Upon examination, it was found that the dung contained many undigested Mesquite seeds, and these, no doubt, were what the squirrel had been eating. The burrows of these animals are usually under a desert shrub such as a Palo Verde, Mesquite, or Cresote Bush, but sometimes they are in the open. The animals are active during the hottest part of the day, but I have never seen them at night, although I have been hunting at all hours between sunset and sunrise. I have watched these animals when they were apparently unaware of my presence, running about the desert floor, and stopping frequently to dig up something from the ground in a fashion similar to that of the eastern Gray Squirrel. The shallow holes which they thus leave are frequently very evident signs of their presence.

9. **Eutamias dorsalis dorsalis** (Baird)

CLIFF CHIPMUNK

Tamias dorsalis, Allen (1895, p. 241).
Eutamias dorsalis, Mearns (1907, p. 288).
Eutamias dorsalis dorsalis, Miller (1924, p. 208); Howell (1929, p. 131).

Material.—5 specimens: 1 ad. and 2 im. males, Aug. 17, 2 im. females, Aug. 25, near Soldier Camp, Santa Catalina Mountains.

Remarks.—*E. d. dorsalis* was found only in the Pine and Fir Forest near Soldier Camp. On August 28, they were noted as being the most common diurnal mammal. They were notably inquisitive, and although the slightest motion would frighten them into hiding, they were soon out again to observe the intruder, or to continue their search for food. One of the specimens was shot as it was eating the meat with which I had baited a steel trap. Though the species was abundant in the Santa Catalinas, it was not observed in the Santa Ritas; and both Allen (1895, p. 243) and Mearns (1907, p. 290) comment on its absence from the Huachuca Mountains.

10. **Sciurus arizonensis catalinæ** Doutt

CATALINA MOUNTAIN GRAY SQUIRREL

Sciurus arizonensis catalinæ Doutt 1931, p. 271.

Material.—6 specimens: 1 ad. male, 4 ad. females, Aug. 17-30, near Soldier Camp, Santa Catalina Mountains; 1 ad. female, July 14, Santa Rita Mountains.

Remarks.—The following comparisons and remarks are taken from the original description (Doutt 1931).

Comparisons.—This new race comes from a region that lies between the range of *S. a. arizonensis*, which occurs to the northward, and that of *S. a. huachuca*, which occurs to the southward; and, as might be expected, it shows characters which are intermediate between the two subspecies. The intermediate character of specimens from this region was noted also by Mearns (1907, p. 280) and by Nelson (1899, p. 97). As compared with *huachuca*, *catalinæ* is Russet instead of Deep Mouse Gray over the rump region; rostrum relatively as well as actually narrower and shallower; interorbital breadth greater; height of braincase less. As compared with *arizonensis*, *catalinæ* has the brown markings confined to the rump region instead of extended continuously from the head to the base of the tail; rump region Russet rather than Tawny Olive; shoulder region Pale Mouse Gray rather than Tawny Olive; interorbital breadth tending to be greater, and height of braincase less.

Remarks.—The series of *S. a. arizonensis* clearly shows that there is a decided seasonal variation in color similar to that mentioned by Mearns (1907, p. 279) in regard to *S. a. huachuca*; similar variation may be expected also in *S. a. catalinæ*.

The specimen from the Santa Rita Mountains, although most similar to *S. a. catalinæ*, can be separated readily from any of the other five specimens by its more Rufous crown patch. In the series of seventeen skins of the species here assembled, it is interesting to note that specimens to the south are grayest, and that northward there is a gradual increase of Rufous or Tawny Olive.

At the time the author was in the Santa Catalina Mountains, these squirrels were feeding on the seeds of White Pine cones, and in this connection the following digest from the field journal may be of interest. On the morning of August 24, I was hunting along the ridge south of Soldier Camp, and having previously seen signs of squirrels working along the ridge, was on the lookout for them. About five hundred yards from camp I shot one out of a White Pine tree, and just a little later saw two others in another White Pine tree. I watched one of these go out to the end of a branch and gnaw off a cone. Instead of letting the cone fall to the ground and going there to eat it, it carried the cone part way back along the branch and there, balancing itself on its hind feet, it held the cone between its front feet and the branch. As it ate the seeds it turned the cone around on the branch with much dexterity. The cones at this time were covered with soft resin and the squirrels became smeared with this, especially on the paws and about the mouth, thus causing the fur there to become badly matted.

11. **Thomomys fulvus intermedius** Mearns*

MOUNTAIN-TOP POCKET GOPHER

Thomomys fulvus, Allen (1895, p. 205), part.

Thomomys fulvus intermedius, Bailey (1915, p. 84); Miller (1924, p. 245); Swarth (1929, p. 351).

Material.—1 ad. female, Aug. 31, near Soldier Camp, Santa Catalina Mountains.

Remarks.—The single specimen obtained does not have the broad dorsal area of plumbeous black extending from the nose to the rump which Mearns mentions in the original description. Unfortunately the skull is badly broken. Workings of Thomomys were found on the Santa Catalina Mountains between 7000 and 8000 feet. Workings were also noted on the Pinal Mountains at 7800 feet, but no specimens were obtained.

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*Since this paper was written, Goldman (1931, p. 419) has described the Pocket Gopher from the Santa Catalina Mountains as a new sub-species, *T. f. catalinæ*.

12. **Perognathus baileyi baileyi** Merriam

BAILEY POCKET MOUSE

Perognathus baileyi, Osgood (1900, p. 41).
Perognathus baileyi baileyi, Miller (1924, p. 280); Swarth (1929, p. 355).

Material.—2 specimens: 1 ad. male, July 7, Florida Canyon, Santa Rita Mountains; 1 ad. female, Aug. 5, Soldier Canyon, Santa Catalina Mountains.

Remarks.—No specimens of this species are recorded by Allen (1895), and the westernmost specimens listed by Osgood (1900, p. 42) are one from Mammoth, Pinal County, and one from the Santa Catalina Mountains. Swarth (1929, p. 355) lists 25 specimens, and comments on the fact that they were all from the west side of the Santa Rita Mountains. Apparently, then, the Mexican Highland Section forms their eastern limit in this region.

13. **Perognathus penicillatus pricei** (Allen)

PRICE POCKET MOUSE

Perognathus obscurus, Allen (1895, p. 216).
Perognathus penicillatus pricei, Osgood (1900, p. 47); Miller (1924, p. 282); Swarth (1929, p. 355).

Material.—2 specimens: 1 ad. female, July 26, 10 mi. south of Florence; 1 ad. male, July 29, 10 mi. north of Florence.

Remarks.—In 1894, W. W. Price, in speaking of this species, stated that it was the most common pocket mouse south of the Mogollon Mesa, outnumbering all other kinds three to one. That only two are represented in this collection is probably due to the fact that we spent very little time in its typical habitat.

14. **Dipodomys spectabilis spectabilis** Merriam

LARGE KANGAROO RAT

Dipodomys spectabilis, Allen (1895, p. 212).
Dipodomys spectabilis spectabilis, Vorhies and Taylor (1922); Miller (1924, p. 290); Swarth (1929, p. 356).

Material.—1 specimen, Sept. 4, between Florence and Tucson along U. S. Highway 80.

Remarks.—The only specimen of this species which was obtained was a badly mangled one found crushed on the highway. Although their workings were abundant in many places, especially on the desert below Florida Canyon, Santa Rita Mountains, yet they successfully evaded all traps placed for them. Price (*see* Allen, 1895, p. 213) also comments on the difficulty of catching them with baited traps, but states they were easily caught in steel traps.

15. **Dipodomys merriami merriami** Mearns

MERRIAM KANGAROO RAT

Dipodomys merriami, Allen (1895, p. 213).
Dipodomys merriami merriami, Grinnell (1914, p. 241, and 1922, p. 73); Miller (1924, p. 291); Swarth (1929, p. 356).

Material.—6 specimens: 1 ad. male, July 11, Florida Canyon, Santa Rita Mountains; 1 ad. male, July 26, 10 mi. south of Florence; 3 ad. females, 1 ad. male, Aug. 4-6, Soldier Canyon, Santa Catalina Mountains.

Remarks.—Kangaroo rats were one of the most common nocturnal animals on the desert. They were found in the same general habitat that *Ammospermophilus harrisii* frequented during the day. At night, these animals were not at all frightened by a light, and I could approach within a few feet to watch them search the desert floor for food. They usually hopped rapidly over open spaces, but stopped to examine carefully the ground under each bush or shrub. Seeds which they found were not eaten on the spot, but were put into their cheek pouches.

16. **Peromyscus maniculatus rufinus** (Merriam)

TAWNY WHITE-FOOTED MOUSE

Peromyscus leucopus rufinus, Allen (1895, p. 232).
Peromyscus sonoriensis rufinus, Mearns (1907, p. 391).
Peromyscus maniculatus rufinus, Osgood (1909, p. 72); Miller (1924, p. 328).

Material.—4 specimens: 2 ad. males and 2 ad. females, Aug. 24-26, near Soldier Camp, Santa Catalina Mountains.

Comparisons.—Compared with the description of *rufinus* given by Osgood (1909, p. 72), these specimens differ as follows:

1. Upper parts Drab to Hair Brown rather than Ochraceous or Tawny Ochraceous.

2. Subauricular tufts not conspicuous.

3. Underparts bluish white rather than creamy white. Compared with topotypes of *rufinus*, the Santa Catalina specimens are much

darker, with sides grayer; rostrum of skull broader and heavier; braincase more rounded; palate wider.

Remarks.—All of these specimens were caught in the Pine and Fir zones on the north slope of the Santa Catalina Mountains. They are uniformly so much darker than the topotypes of *rufinus* that for a time it was suspected that they might represent a new race. Very recently, however, another specimen from the same locality has been added to the collection of the Museum of Vertebrate Zoology. It is so much more like *rufinus* that it throws grave doubts upon the advisability of recognizing the animals from the Santa Catalinas as a new form. At the present time, therefore, it seems prudent to refer these specimens to *rufinus* until a larger series can be obtained.

From the evidence at hand, there seems to be a difference in color which corresponds to a difference in geographic area. Allen (1895, p. 232) records a series of 182 specimens from the White, Graham, and Chiricahua mountains. The White Mountains rise from the Mogollon Mesa just as the San Francisco Mountains do, and Allen (*loc. cit.*, p. 233) states that "The White Mountain series seems not to differ appreciably from specimens of *rufinus* from the San Francisco Mountains, the type locality of the subspecies." He had 68 specimens from the White Mountains. The Graham, Chiricahua, and Santa Catalina mountains, on the other hand, all belong to the Mexican Highland Section, and rise out of desert plains. Allen had 25 specimens from the Graham Mountains, and commented on their "broad blackish dorsal area," and the "paler and more mixed with blackish" rump and sides as compared with the White Mountain series. He added, further, that he had two specimens from the same locality which showed remnants of a tawny red pelage, and so he concluded that the color of the majority of his specimens was a seasonal feature. The series of 89 from the Chiricahua Mountains, he stated was quite similar to the Graham Mountain series. The present specimens from the Santa Catalina Mountains also appear to be more like the Graham Mountain series than like *rufinus* from San Francisco Mountain, the type locality.

Thus it is seen, that specimens coming from mountain peaks in the Mexican Highland are darker than specimens from the mountains which rise from the Mogollon Mesa. However, for the revision of the genus, Osgood had specimens from all the above localities except the Santa Catalina Mountains, yet he does not mention this difference in color. Further study should be made of a large series from this region.

17. **Peromyscus boylii rowleyi** (Allen)

Rowley White-footed Mouse

Peromyscus rowleyi, Allen (1895, p. 227).
Peromyscus boylii pinalis, Mearns (1907, p. 416).
Peromyscus boylei rowleyi, Osgood (1909, p. 145).
Peromyscus boylii rowleyi, Miller (1924, p. 339); Swarth (1929, p. 363).

Material.—8 specimens: 1 ad. female, July 11, Florida Canyon, Santa Rita Mountains; 1 ad. male and 1 ad. female, July 14, Old Baldy Peak, Santa Rita Mountains; 2 ad. males and 1 im. female, Aug. 26 and 30, near Soldier Camp, Santa Catalina Mountains; 2 ad. females, July 29, Pinal Peak, Pinal Mountains.

Remarks.—*P. b. rowleyi* was found on all the mountains visited, ranging from the Lower Encinal to the Fir Forest, but it was not found below the Lower Encinal. The altitudinal range noted above is from 4200 to 8450 feet.

One of the specimens collected was shot from an oak tree on a moonlight night; it was climbing about on the branches twenty feet above the ground.

18. **Neotoma albigula albigula** Hartley

White-throated Wood Rat

Neotoma albigula, Mearns (1907, p. 476); Goldman (1910, p.31).
Neotoma albigula albigula, Miller (1924, p. 378); Swarth (1929, p. 364).

Material.—9 specimens: 1 ad. female, nursing, July 9, 1 im. female, July 11, Florida Canyon, Santa Rita Mountains; 4 ad. males and 3 ad. females, Aug. 16 and 19, near Desert Laboratory, Tucson.

Remarks.—These were abundant near the Desert Laboratory, at Florida Canyon, and along the U. S. highway, 10 miles south of Florence, but none was found at the higher altitudes in the mountains.

19. **Neotoma mexicana bullata** Merriam

Santa Catalina Mountain Wood Rat

Neotoma mexicana bullata, Mearns (1907, p. 491); Goldman (1910, p. 59); Miller (1924, p. 384).

Material.—3 specimens: 1 ad. male, 1 ad. female, 1 im. female, Aug. 24-29, near Soldier Camp, Santa Catalina Mountains.

Remarks.— *N. m. bullata* is apparently a rather rare form. Goldman had only one, the type, in his revision of the genus *Neotoma.* Mearns listed seven from the Huachuca Mountains and one from the San Luis Mountains, but Goldman evidently considered that these represented some other form. While we were collecting near Soldier Camp, they were not abundant, only three specimens being taken. They were all caught near a rock ledge in Fir Forest.

20. **Neotoma lepida stephensi** (Goldman)

STEPHENS WOOD RAT

Neotoma stephensi, Mearns (1907, p. 493).
Neotoma lepida stephensi, Goldman (1910, p. 80); Miller (1924, p. 388).

Material.—1 ad. female, July 29, Pinal Peak, Pinal Mountains.

Remarks.—Specimens of the Stephens Wood Rat are apparently not very abundant in collections. Mearns had no specimens; he merely lists the species and gives the original description. He supposes it to be the form found in the Verde Mountains. Goldman, during his revision of the genus, had only 27 specimens. There are three in the Museum of Vertebrate Zoology collection from Deadman's Flat, San Francisco Mountain. As far as known, the present specimen from Pinal Peak is the most southern record of the species and extends its known range approximately 160 miles southward.

21. **Erethizon epixanthum couesi** Mearns

ARIZONA PORCUPINE

Erethizon epixanthus couesi Mearns (1897, p. 723).
Erethizon epixanthum couesi, Miller (1924, p. 437).

Material.—1 im. female, Aug. 15, 3 mi. northwest of Tucson.

Comparisons.—This specimen is a young individual, scarcely two-thirds grown. It is similar in color to specimens from near Flagstaff and San Francisco Mountain, Arizona. A specimen of about the same size, from Plumas County, California, is also similar to it in color; but two adults from Lassen and Tehama counties of northern California are much browner. A series from White Pine County, Nevada, shows color differences which are just as great as those between the specimens from Arizona and California mentioned above. With such variation in specimens from a single locality, it is impossible to decide, from the material at hand, whether *couesi* is a valid form or not.

Remarks.—This animal was found by the side of the road; it had been hit by an automobile, and its skull was badly crushed. Its presence in the desert so far from any mountains where conditions favorable for its existence would occur, is unusual. If it actually were roaming about on the desert, it shows a remarkable ability to range over great distances and diverse conditions. There is a possibility, however, that the animal was brought from the mountains in somebody's automobile and then was lost or turned loose on the desert.

22. **Lepus alleni alleni** Mearns

ANTELOPE JACK RABBIT

Lepus alleni, Allen (1895, p. 201); Nelson (1909, p. 117).
Lepus alleni alleni, Miller (1924, p. 456); Swarth (1929, p. 364).

Material.—6 specimens: 1 ad. female, June 29, Quinlan Mountains; 1 ad. male, Aug. 11, mouth of Soldier Canyon, Santa Catalina Mountains; 4 ad. females, Aug. 20, near Oracle.

Remarks.—This species occurred throughout the Desert Region and was just as abundant as *Lepus californicus eremicus.*

23. **Lepus californicus eremicus** (Allen)

ARIZONA JACK RABBIT

Lepus texianus eremicus, Allen (1895, p. 202).
Lepus californicus eremicus, Nelson (1909, p. 140); Miller (1924, p. 459); Swarth (1929, p. 367).

Material.—7 specimens: 1 ad. male, Aug. 9, Cat Mountain, Tucson Mountains; 1 ad. male, Aug. 11, mouth of Soldier Canyon, Santa Catalina Mountains; 1 im. female, 1 ad. male, Aug. 19, Desert Labotory, Tucson; 1 ad. male, Aug. 17, near Walnut, northwest base of the Santa Catalina Mountains; 1 ad. male and 1 ad. female, Aug. 20, near Oracle.

Remarks.—The single adult male from Soldier Canyon is not typical *eremicus*, and several of its characters suggest *texianus*, as described by Nelson (1909, p. 142). Compared with specimens of *eremicus* from near Tucson, it presents the following characters: back, sides, and ears grayer; rump almost white; tail short (80 mm.), and not so intense black; black on tips of ears not so intense nor so extensive; size large (total length 604 mm.). Such intergrades are not uncommon in New Mexico and eastern Arizona. This specimen is from a little farther southwest than any previous records.

Throughout the region where collections were made, *eremicus* was abundant in the Desert Region up to 4500 feet; above this it was less common, and did not occur in the Pine and Fir Forest on the Santa Catalina or Santa Rita mountains.

On the night of August 6, I caught a small female Jack Rabbit, which was probably several days old. This rabbit lived for eighteen days, and during that time the following observations were made. Although it was out of the nest and able to run very fast, it was still suckling. For two days it had no food. Then a goat was procured, and it drank greedily of warm goat's milk at the first feeding. Later it refused to drink more than four to six cubic centimeters of milk at a time, but wanted to be fed frequently, every hour or so. After five days, the rabbit began drinking fifteen to thirty cubic centimeters at a feeding, and was fed but three times a day. It seemed to prefer goat's milk to cow's, and warm milk to cold. On the sixth day after capture, it, for the first time, showed interest in grass blades, smelling at some in its cage. On August 19, it was observed to eat a few small lumps of sand, and again smelled at blades of grass, but ate none. It was not until August 20, fourteen days after capture, that it ate several blades of grass.

After eating, from the very first, the young rabbit always washed its paws and face as a cat does, this washing operation being preceded by a peculiar shaking of the paws, as if, perhaps, to shake sand from them. As it grew older, this shaking of the paws became more pronounced. On the sixth day, a nest was made in one corner of the cage, from grass which I had placed there. At this time it was quite tame, and liked to be petted on the head and liked to lick our arms, perhaps for salt from perspiration. The rabbit seemed to be affected by intense sunlight. On August 20, it was left in the direct sun for a short time, and soon appeared ill, quaked and shivered, and its sides heaved. When placed in the shade, however, it became normal again after a few minutes. On August 22, sixteen days after its capture, it was taken to camp in the Santa Catalina Mountains, at an elevation of 8000 feet. During the first night it seemed cold, although the nest was warm. The next day it was noticeably wilder, and in trying to escape me, fought and scratched. The second morning, it was found dead in its cage. Its stomach, when examined, appeared normal, and was half full of grass. Its death was probably due to the extreme change in conditions involved at this altitude.

24. **Sylvilagus audubonii arizonæ** (Allen)

ARIZONA COTTONTAIL

Lepus sylvaticus arizonæ, Allen (1895, p. 202).
Sylvilagus auduboni arizonæ, Nelson (1909, p. 222); Grinnell (1914, p. 250); Swarth (1929, p. 367).
Sylvilagus audubonii arizonæ, Miller (1924, p. 471).

Material.—5 specimens: 2 ad. females, 1 ad. male, Aug. 16 and 19, Desert Laboratory, Tucson; 1 ad. female, Aug. 20, near Oracle; 1 skull only, July 26, 10 mi. south of Florence.

Remarks.—This species was abundant in the Desert near Tucson and Oracle. One of the females taken near the Desert Laboratory on August 16, contained two embryos. Its pelage was much more worn than others taken at the same time.

25. **Pecari angulatus sonoriensis** (Mearns)

SONORAN PECCARY

Tayassu angulatum sonoriense, Mearns (1907, p. 162).
Pecari angulatus sonoriensis, Miller (1924, p. 481).

Material.—1 ad. male, Aug. 15, near Bear Canyon, Tortillita Mountains.

Remarks.—This specimen is of a very old male; the tubercles on the molars are worn entirely off, leaving a smooth, polished surface. It was shot from a herd of eight or ten which probably lived near Bear Canyon. Tracks leading up the dry creek bed to a small spring at the side of the canyon, indicated that the herd frequently visited this place for water. *Ammospermophilus h. harrisii* was the only other mammal noted during the few hours spent in the Tortillita Mountains.

LIST OF MAMMALS OBSERVED OR REPORTED IN THE REGION BUT OF WHICH NO SPECIMENS WERE OBTAINED.

1. KIT FOX

Vulpes macrotis neomexicana Merriam

We saw a Kit Fox in captivity a few miles northwest of Tucson on August 15. The Mexican who owned it said that he had captured it on the desert when it was very young. Although necessary to keep it tied, it was quite tame.

2. COYOTE

Canis mearnsi Merriam

Coyotes were not as abundant as had been expected. The only evidence that we had of their presence was at the base of the Quinlan Mountains, June 29, where several were heard in chorus, up one of the side canyons.

3. MOUNTAIN LION

Felis concolor azteca (Merriam)

Shortly after our arrival at Old Baldy in the Santa Rita Mountains, July 13, Mr. Gilman, the fire lookout on duty at that time, told us that a few days previously a Mountain Lion had killed a deer some distance down the mountain from the cabin.

4. DEER

Odocoileus couesi (Coues and Yarrow)?

Deer were seen several times near Soldier Camp, Santa Catalina Mountains, usually in herds of three to five. They were not shy, and on several occasions I was able to approach within a few yards of them. One morning, a buck with a splendid set of antlers came within a hundred yards of camp. Deer were reported on the Santa Rita Mountains also, but we saw none there.

SUMMARY

In the present paper, a brief discussion is presented of the geography and vegetation of the region about Tucson, Arizona. Following this, twenty-three genera and twenty-nine species and subspecies of mammals are recorded and discussed at more or less length.

It is pointed out that specimens of *Otospermphilus grammurus grammurus*, *Peromyscus maniculatus rufinus*, and *Sciurus arizonensis* occurring north of the Gila and Salt Rivers on the high plateaus, are more rufous in color than specimens of the same species south of these rivers on the mountains of the Mexican Highland. The parallel of thin hairy covering and heavy pigmentation of the skin between *Ammospermophilus harrisii harrisii* and *Citellus tereticaudus neglectus*

is indicated, and it is suggested that this pigmentation may be a protection against the intense sun light.

It is pointed out that the range of *Ammospermophilus harrisii saxicola* does not extend west to the Colorado River, but that it lies south of the Gila River, and runs in a north and south, rather than in an east and west direction. The supposed presence of a colony of *Ammospermophilus harrisii harrisii* in Cataract Canyon, where it would be surrounded by *Ammospermophilus leucurus*, is noted. An attempt is made to define the range of *Ammospermophilus harrisii harrisii* in Arizona, and the unusual occurrence of *Erethizon epixanthum couesi* in the desert is recorded. Notes are presented on the life, in captivity, of a young Jack Rabbit, *Lepus californicus eremicus*. Its transportation to a mountain top is suggested as a possible cause of its death. It is noted also that faunal and floral boundaries of the region coincide with geographic boundaries, and that the Gila and Salt Rivers seem to mark the boundary of a distinct faunal area across the Mexican Highland.

Submitted, November 1932.

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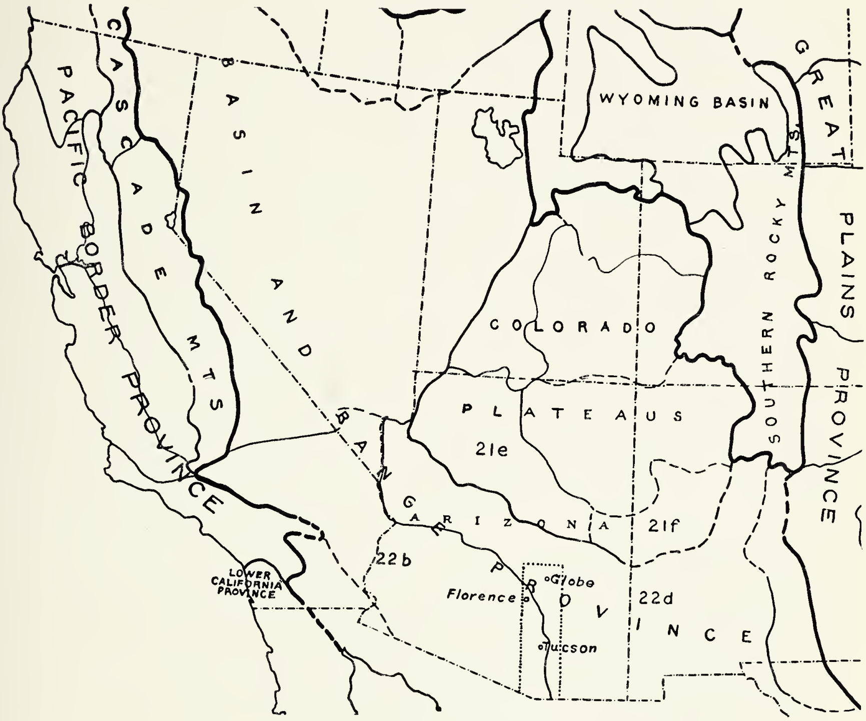
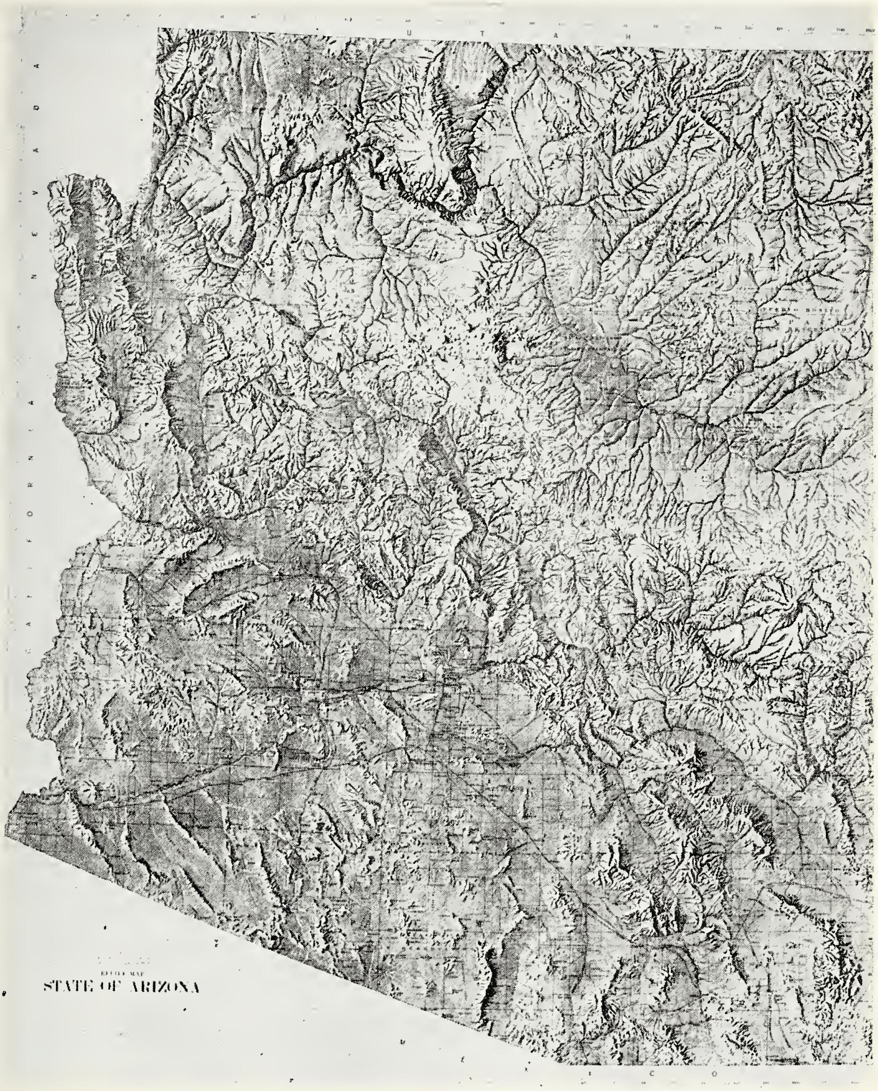


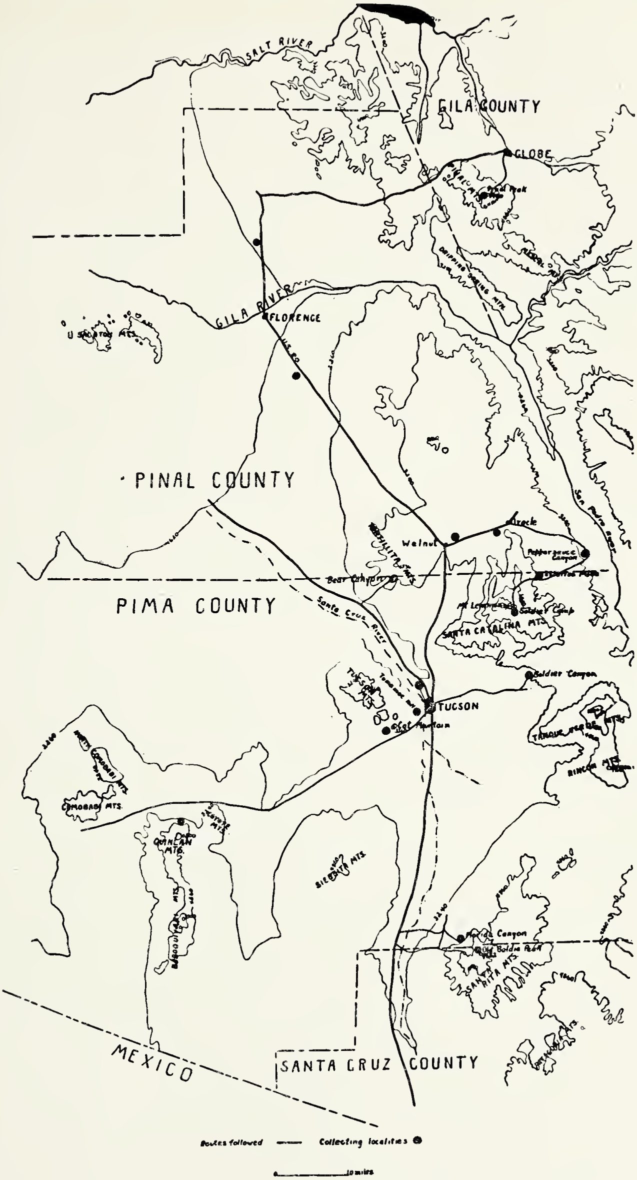
Map of a portion of southwestern United States showing physical divisions. Redrawn from Fenneman, 1930. (*See* pages 243-244.)

21 e—Grand Canyon Section of the Colorado Plateaus Province.
21 f—Datil Section of the Colorado Plateaus Province.
22 b—Sonoran Desert Section of the Basin and Range Province.
22 d—Mexican Highland Section of the Basin and Range Province.

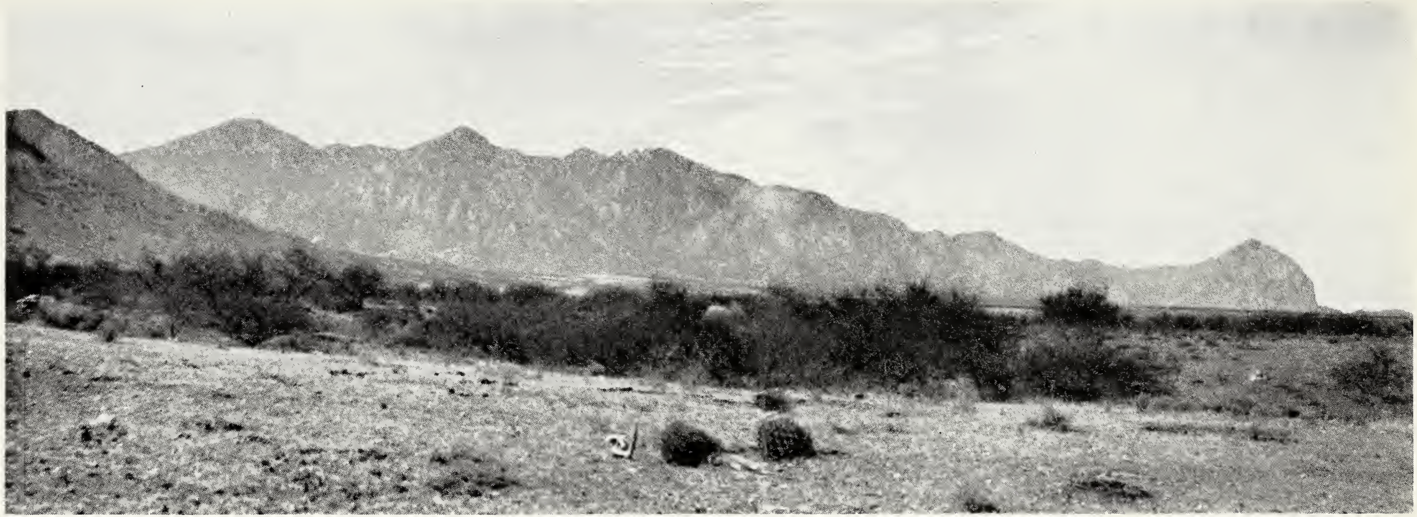
The dotted rectangle in southern Arizona indicates the area covered by the map on Plate XXIX.



Relief map of Arizona showing the high plateau land in the north, the partly connected and the isolated mountain ranges in the southeast, and the low, short mountains studding the plains in the southwest. Photographic copy of the U. S. Geological Survey Relief Map of Arizona, 1925. (*See* pages 243-244.)



Contour map of the portion of southeastern Arizona where collections were made, showing localities discussed in this report. The area covered by this map is shown on Plate XXVII by the dotted rectangle. (*See* pages 241-243.) Map drawn by Mrs. Margaret T. Doutt.



Santa Rita Mountains and White House Canyon as seen from mouth of Florida Canyon. July 7, 1927. Scanty vegetation of desert floor illustrated in fore-ground, and more luxuriant vegetation of small arroyos in center. In distance, alluvial fans emerge from White House Canyon and from smaller canyons along mountain side. These fans form an outwash plain which grades off to level of desert at right of picture.

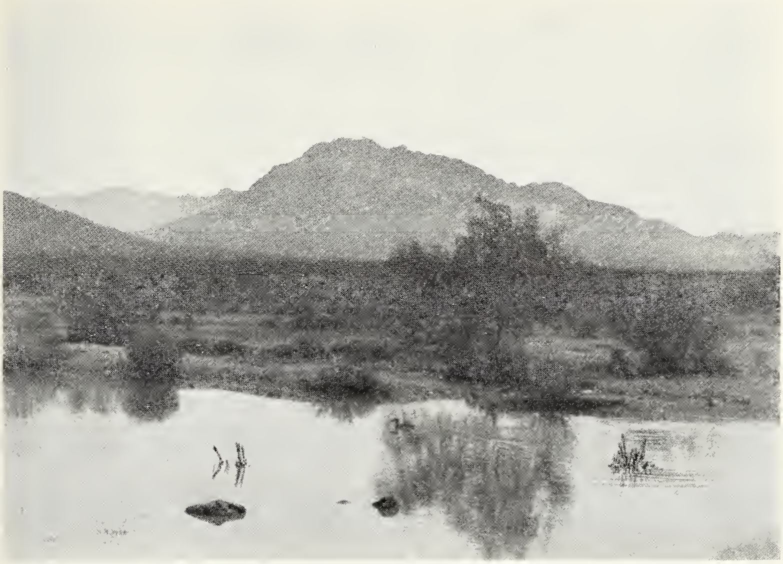


FIG. 1. Near Sawtooth Mountain, Tucson Range. June 28, 1927. Lower Bajada. (*See* page 246.) Vegetation composed largely of Creosote Bush. Temporary desert pool in foreground is characteristic in this association after heavy rains.

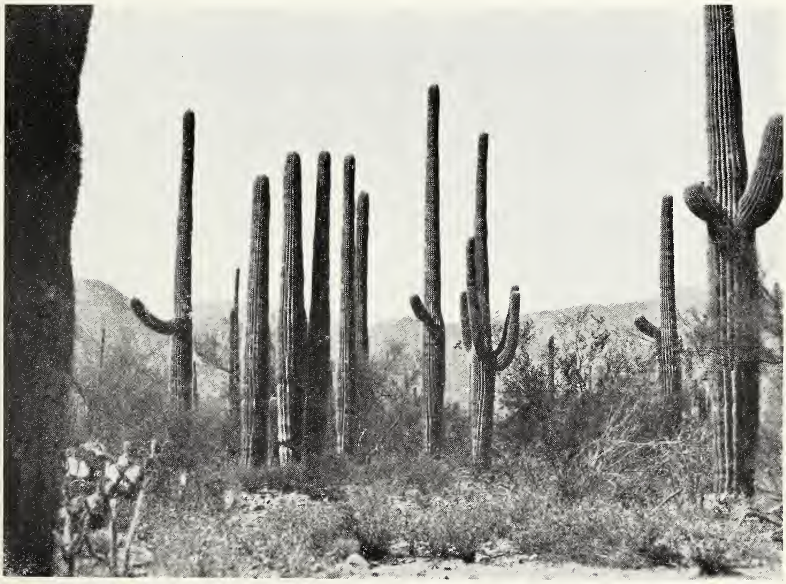


FIG. 2. Near Sawtooth Mountain, Tucson Range. July 24, 1927. Upper Bajada. (*See* page 246.) Group of Giant Cactus in center of picture.

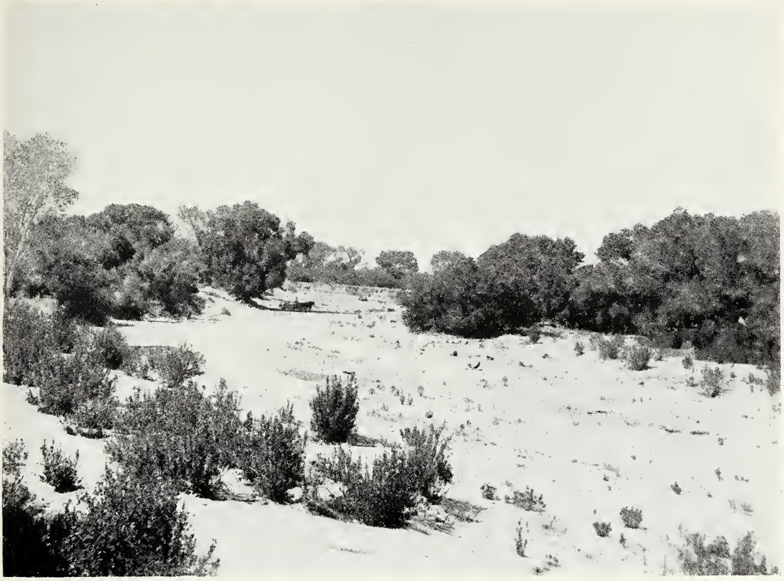


FIG. 1. Santa Cruz River, near Tucson. Sept. 1, 1927. Large Desert Arroyo. Dry stage. (*See* page 246.)

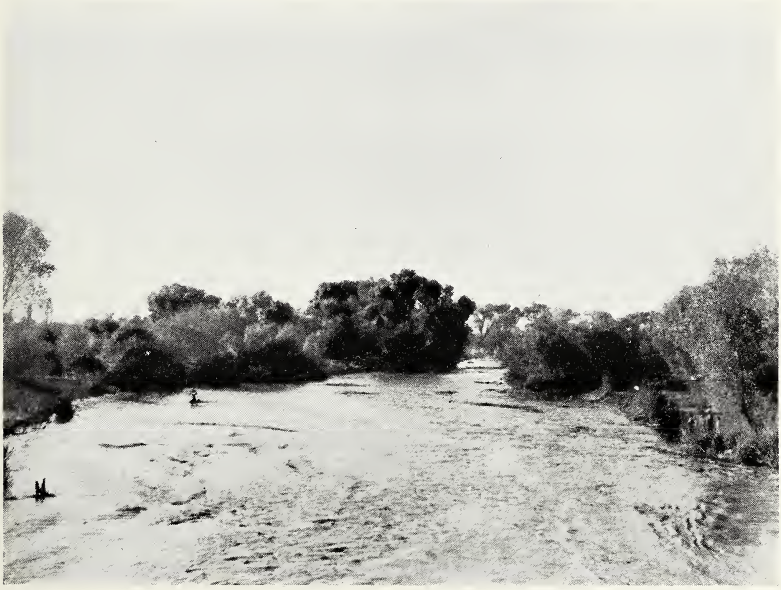


FIG. 2. Santa Cruz River, near Tucson. Aug. 1, 1927. The same Desert Arroyo as illustrated above. Flood stage.

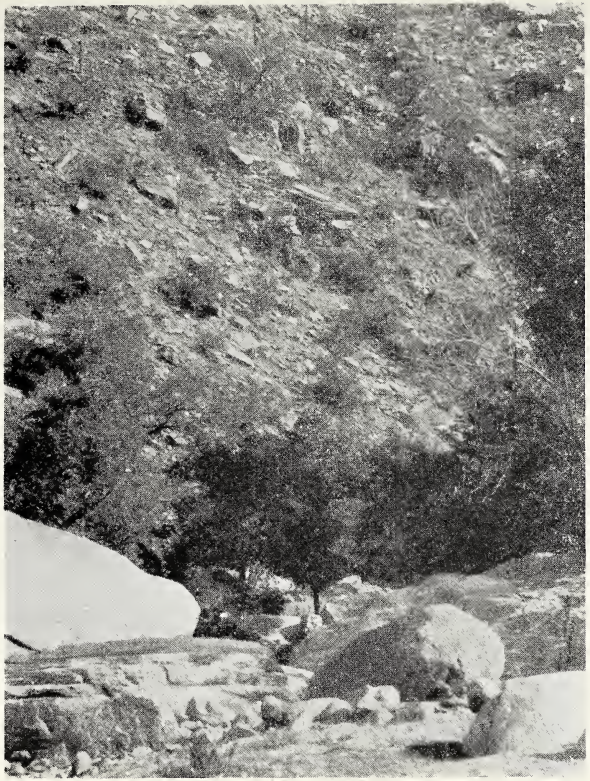


Fig. 1. Sabino Canyon, Santa Catalina Mountains. June 24, 1927. Desert Canyon in foreground; Desert Slope in background. (*See* pages 246-247.)

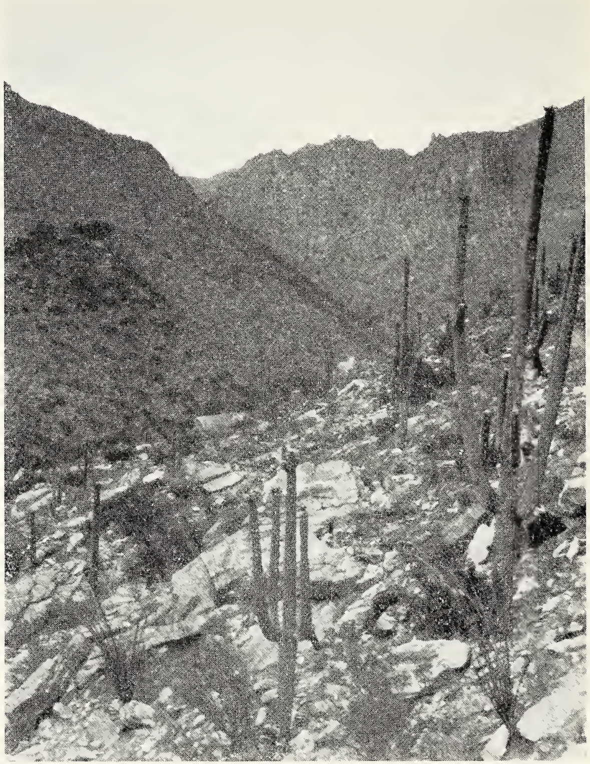


Fig. 2. Sabino Canyon, Santa Catalina Mountains. June 25, 1927. Lower Desert Slope. (*See* page 247.) Giant Cactus (*Carnegiea gigantea*) and Ocotilla (*Fouquieria splendens*) in foreground.

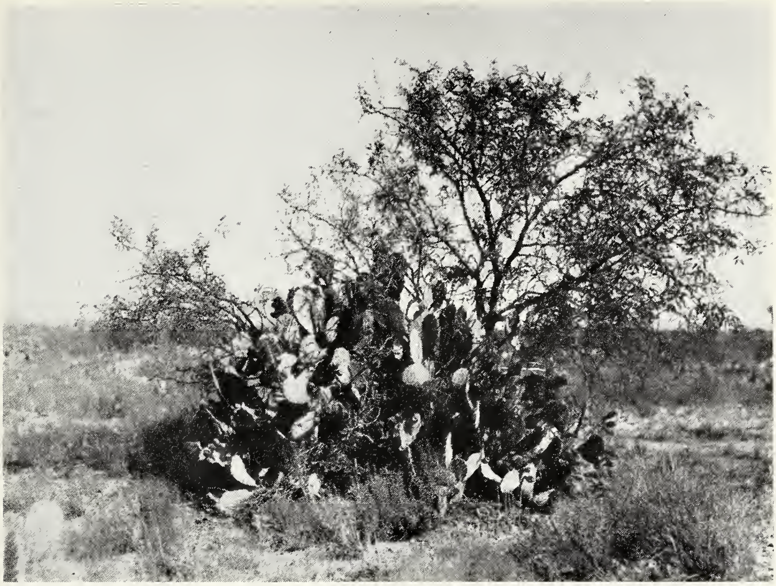


FIG. 1. Near Oracle, Santa Catalina Mountains. Aug. 22, 1927. Upper Desert Slope. (*See* page 247.) Prickly Pear in fruit.

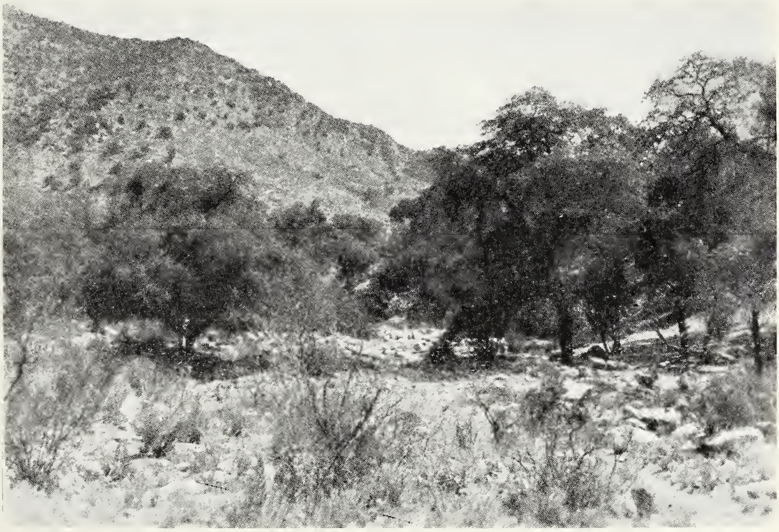


FIG. 2. Sabino Canyon, Santa Catalina Mountains. Photo by Dr. E. H. Graham April 2, 1928. Lower Encinal. (*See* page 248.)

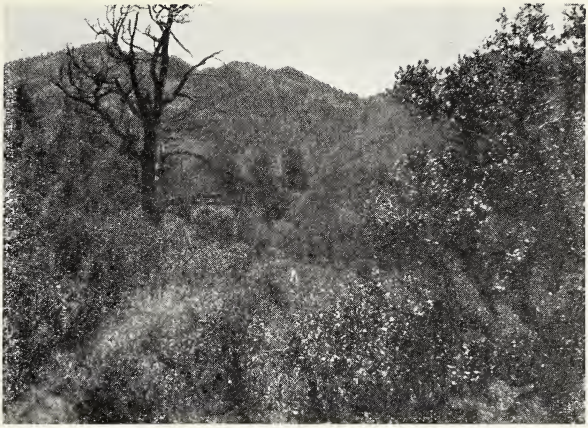


FIG. 1. Florida Canyon, Santa Rita Mountains. Photo by Dr. E. H. Graham July 13, 1927. Upper Encinal. (*See* page 248.)

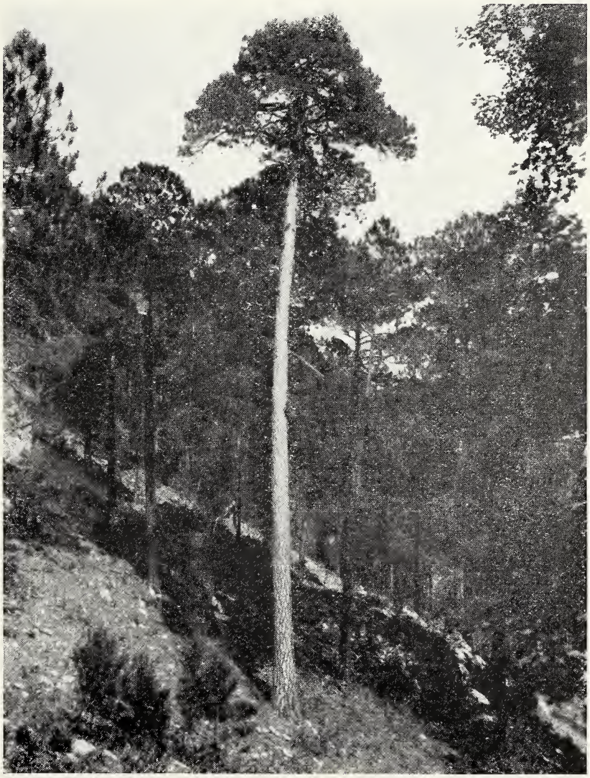


FIG. 2. Near Mount Lemmon, Santa Catalina Mountains. Aug. 28, 1927. Pine Forest. (*See* page 248.)

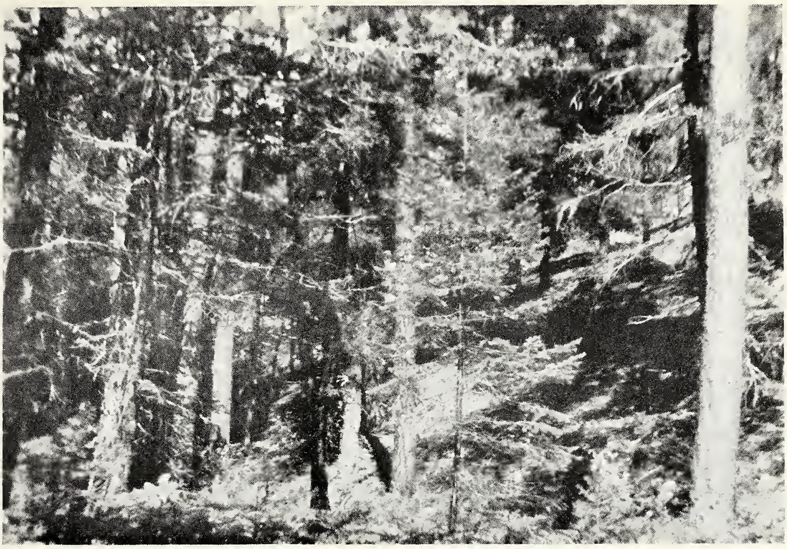


FIG. 1. Near Soldier Camp, Santa Catalina Mountains. Photo by Dr. E. H. Graham Aug. 24, 1927. Fir Forest. (*See* page 249.)

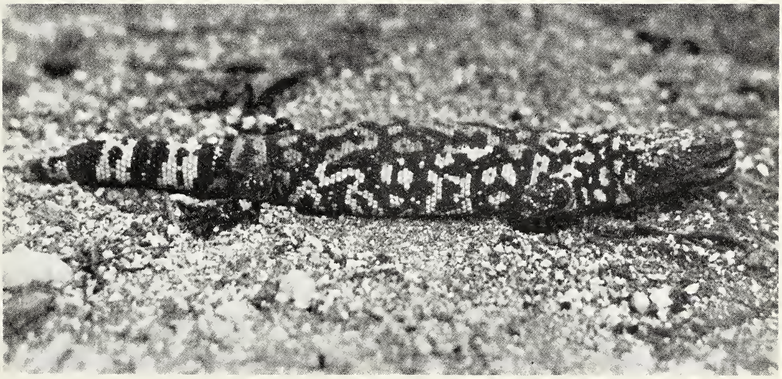


FIG. 2. Soldier Canyon, Santa Catalina Mountains. Aug. 4, 1927. Gila Monster. (*See* page 254.)

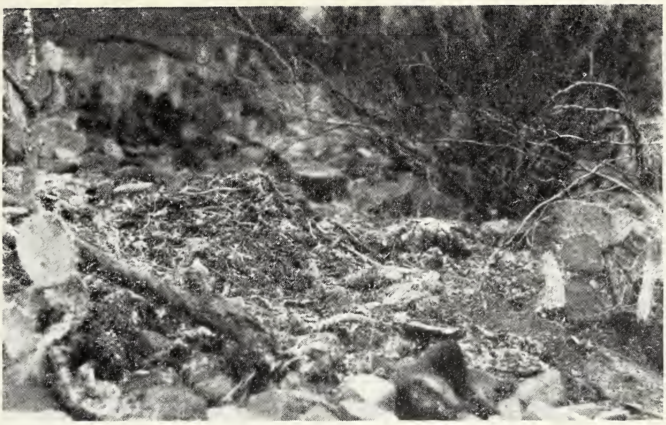


FIG. 1. Near Tucson. Aug. 16, 1927. Pack Rat's nest. (*See* page 265.)

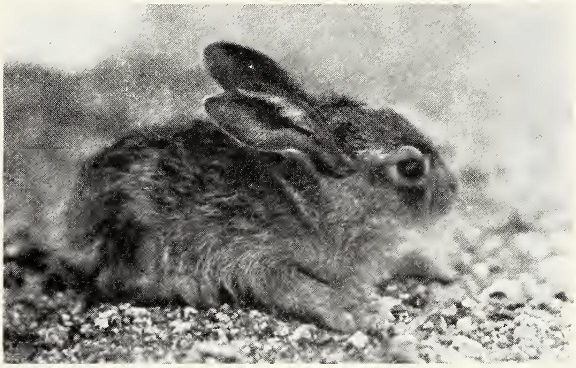


FIG. 2. Soldier Canyon, Santa Catalina Mountains. Aug. 5, 1927. Young Jack Rabbit. (*See* pages 267-268.)

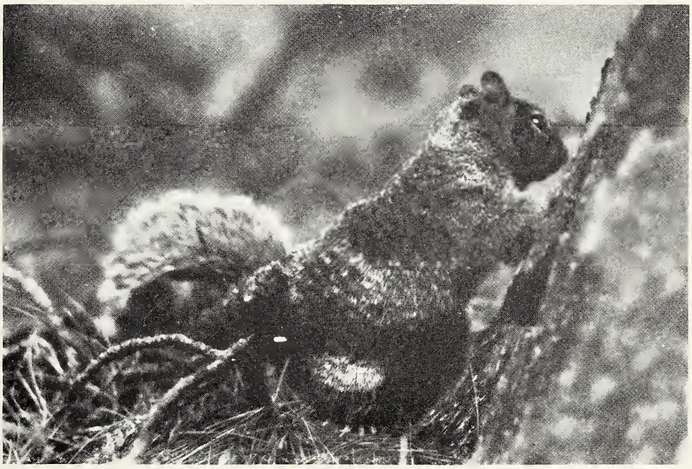


FIG. 3. Soldier Canyon, Santa Catalina Mountains. Aug. 27, 1927. Rock Squirrel. (*See* pages 253-255.)

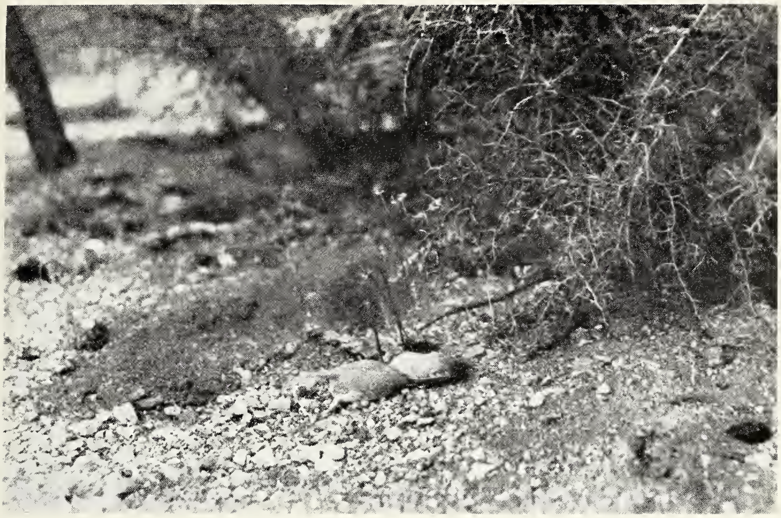


FIG. 1. Soldier Canyon, Santa Catalina Mountains. Aug. 8, 1927. Dolans Spring Ground Squirrel. (*See* page 255.) Burrows of these animals were usually under some sheltering vegetation as is here illustrated.

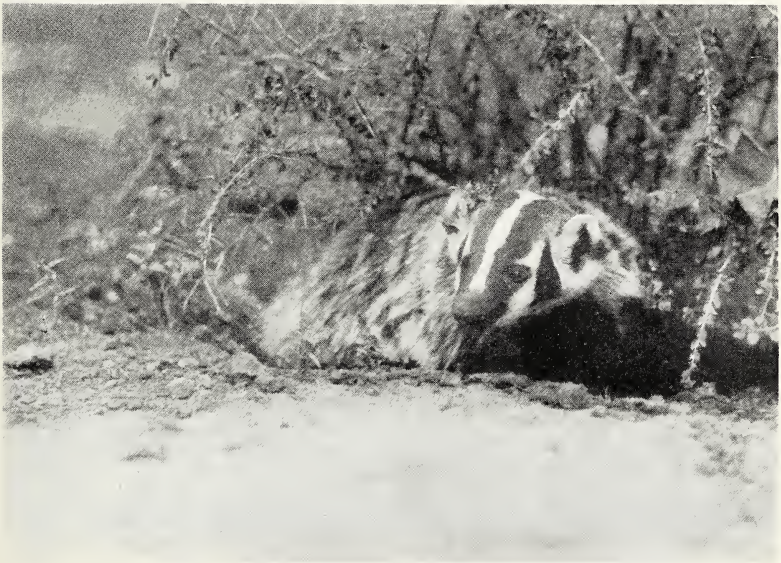


FIG. 2. Near Tucson. July 23, 1927. Badger. (*See* page 253.)

V. A MIOCENE MICROFAUNA AND FLORA FROM THE ATRATO RIVER, COLOMBIA, SOUTH AMERICA.

By I. P. Tolmachoff

INTRODUCTION

In 1927, the writer received for examination a specimen of dark greenish fossiliferous limestone brought by L. G. Huntley[1] from a part of Colombia known geologically only in a very general way. As the specimen itself was found, after a preliminary examination, to be very interesting in different respects, the writer decided to examine it more in detail and publish the results of his research.

All species described in the present paper belong to the Carnegie Museum of Pittsburgh (collection No. 8016) and are deposited in the collections of the Sections of Invertebrate (C. M. I. F.) and Vertebrate (C. M. V. F.) Paleontology and also in the Paleobotanical collection of the Section of Botany. Reference to the catalog numbers is given after the description of each species, and also in the explanations of the plates.

With the exception of the photographs, all figures were drawn by E. R. Eller of the Carnegie Museum, to whom the writer feels deeply obliged for this friendly help.

L. G. Huntley delivered the following data as to the geology of the locality in which he had found the specimen:

"The specimen of black fossiliferous lime occurs at the base of a thick section of shallow fresh-water shales and sands in the Atrato Valley, Colombia, on the west flank of the western Cordillera of the Andes Mountains,[2] about thirty kilometers due east from the town of Quibdo.[3] This is near the western boundary of the province of Antioquia in a region known as the Choco. From its position in the section, I should judge it must be of either Oligocene or Upper Eocene.

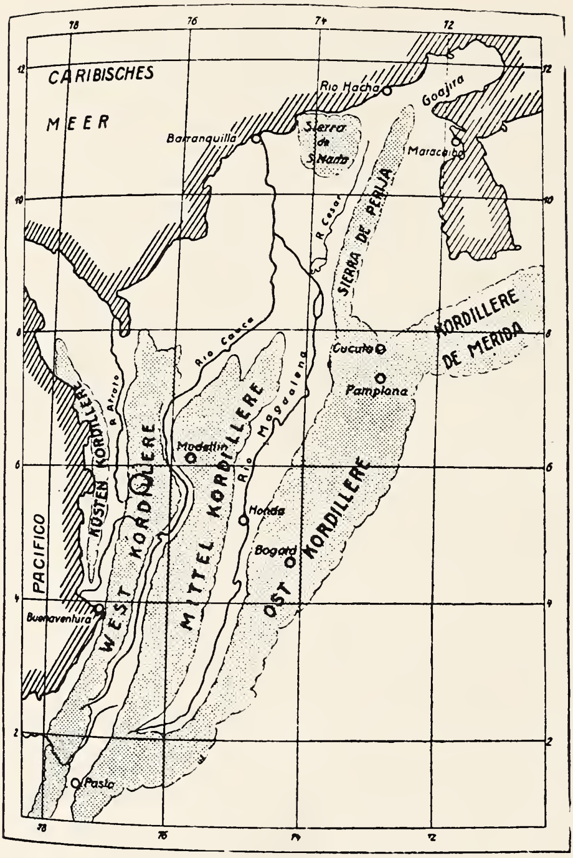
---

[1] Huntley and Huntley. Petroleum Geologists and Engineers. Pittsburgh, Pennsylvania.

[2] The most important geographical features of Western Colombia are represented schematically on the small map reproduced (in the scale about 150 miles to 1 inch) from Otto Stutzer's paper "Beiträge zur Geologie und Mineralogie von Kolumbien (Sûdamerika)" published in Neues Jahrbuch f. Min., Geol. u. Pal., B. Bd. LII, Abt. B, 1925. S. 163.

[3] It will correspond approximately to 76° 28′ W. and 5° 45′ N. The locality is marked on the map with a circle.

Issued August 10, 1934.



This is for the reason that as one travels eastward toward the mountains, a thick section of Middle and Lower Eocene coal beds is encountered below this black limestone. There is an angular unconformity a short distance stratigraphically below the black limestone from which this specimen was taken."

The previous knowledge of geology of this area is very inadequate. "Concerning the Atrato River Valley, neither of us knows anything" say Washburn and White.[4] According to Stutzer "Westkordillere ist geologisch fast unbekannt."[5] About the Coastal Cordillera he says: "Dieselbe ist noch wenig erforscht." So far as is known to the writer, nothing has been published on the geology of the particular part of Colombia from which the specimen was brought except in general geological reviews of the geology of Colombia or of the northern part of South America, covering, of course, this area as well. It is unlikely that some unpublished geological report may be found in the files of different concerns interested in the oil geology of Northern Colombia. As has been positively stated to the writer by L. G. Huntley and his associates who are well informed on all the geological and mining work carried on in this part of South America, no geologist since L. G. Huntley has visited this locality.

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[4] Washburn, W. and White, K. D., Oil Possibilities of Colombia: Trans. A. I. M. M. E., LXVIII, 1923, p. 1031.

[5] Stutzer, O., Beiträge zur Geologie und Mineralogie von Kolumbien (Südamerika): Neues Jahrbuch, Beil. Band LII, Abt. B, 1925, S. 164.

About the same thing may be repeated in reference to the paleontology of this area. Papers on Tertiary fossils of Colombia published lately by F. M. Anderson[6] and N. E. Weisbord[7] refer chiefly to fossils from the coastal regions of Colombia and deal almost exclusively with the macrofauna. Anderson's papers have indeed many references to abundant and diverse Foraminifera, but only a few of the latter were described in detail. The microfauna of Colombia which has been examined by paleontologists of different oil enterprises still awaits description. As the writer has learned by chance such a description is now in preparation, but it still refers to localities very distant from the one under consideration.

It was a rather difficult job to extract the fossils from the hard rock, especially as the specimens were small and provided little material for experimenting. At first the writer tried strong heating of the specimens followed by quick cooling in water. A number of fossils were obtained in this way, but the rock and fossils were becoming reddish brown, and the fossils were often partly damaged. Most of the fossils were cleaned out by means of simply crushing the rock specimen with a heavy hammer, the specimen itself being wrapped in thick paper. The first crushing yielded rather coarse material. Fragments were examined under a microscope and a few fossils cleaned out with the usual instruments. After examination, the crushing was repeated.

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[6] Anderson, F. M., I. The marine Miocene Deposits of North Colombia: Proc. Cal. Ac. Sc., IV Ser, XVI, 1927, pp. 87-95, pls. 2-3; II. Notes on Lower Tertiary Deposits of Colombia and their molluscan and foraminiferal Fauna: Ibidem, XVII, 1928, pp. 1-29, pl. 1; III. Marine Miocene and related Deposits of North Colombia: Ibidem, XVIII, 1929, pp. 73-213, pls. 8-23.

[7] Weisbord, N. E., Miocene Mollusca of Northern Colombia: Bull. Am. Pal., XIV, No. 54, pp. 1-74, pls. 1-9, 1929.

This time much of the finer material was washed out by passing the crushed rock through sieves of different meshes. The different portions obtained in this way were examined under a microscope, the fossils picked out and cleaned finally with brush and needle. Adhesive tape, on which the fossils were fixed for cleaning, was used very successfully in the way described by the writer in another place.[8]

This crushing method was good for microfossils, but certainly was detrimental for larger ones. Bryozoa, for example, were thus obtained only in the form of fragments which could not be well identified. Most of the gastropods were cleaned out of the matrix in the form of inner casts. One very interesting and abundantly represented form *Asterias* (?) *huntleyi* m. was recovered only in the form of isolated disconnected parts.

CORRELATION

As was mentioned above, L. G. Huntley concluded that the fossiliferous limestone was either Oligocene or Upper Eocene, chiefly because of its overlying coal beds which he believed to be of the Middle and Lower Eocene. However, he mentioned also an angular unconformity below the black limestone, which makes the correlation, inasmuch as it depends on connection with coal beds, not so safe. The black limestone can, therefore, have a much higher stratigraphic position than was suggested by L. G. Huntley. Even though coal-bearing strata may be Eocene, this cannot be definitely established at the present time. In White's opinion Colombian coal may be Eocenic or even Cretaceous.[9] According to Grosse, geologists Regel, Tulio Ospina, and Posada considered the coal formation of Antioquia Cretaceous, while Scheibe attributed to it a Tertiary age, chiefly on account of an unconformity at the base of the formation.[10]

A few animal fossils collected by Grosse in the coal formation were identified by Steinmann who attributed to them the late Middle or even Young Tertiary Age.[11] More numerous plant fossils were examined by Kransel who considered them to be Lower Tertiary.[12] Grosse himself was apparently more in favor of Kransel's correlation than Steinmann's although he did not deny the possibility of a higher position of coal-bearing strata "höchstens mitteltertiäres Alter."[13] Grosse came to his conclusion, however, not so much on the basis of paleontological evidence, as of general geological relations between coal-bearing strata and other formations of the Northwestern part of South America. The Colombian Coal Formation can not be Cretaceous, since it is clearly younger than the Lower Tertiary granite and diorite of the Andes.[14] Correlation with the coal formation of Northern Peru is also impossible because the latter was deposited during a period of great eruptive activity in the Tertiary. This activity could not have been earlier than the Middle Tertiary, as is shown by the rich fossil flora found in volcanic tuffs in Bolivia. In Antioquia effusives are lacking within the coal formation, but cover it. Thus the Colombian coal is older than that of Peru and is not represented in the latter country. In some localities the Colombian coal formation is also covered discordantly by young Tertiary conglomerates[15] which fact certainly limits the possibility of its eventual correlation with high Tertiary horizons.

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[8] Tolmachoff, I. P., A Method of Cleaning Microscopical Fossils: Science, LXXIII, No. 1879, January 2, 1931, p. 15.

[9] Washburn, W. and White, K. D., Op. cit., p. 1023.

[10] Grosse, E., Geologische Untersuchung des Kohlenführenden Tertiärs Antioquias, S. 105, Berlin, 1926.

[11] Grosse, E., Op. cit., S. 104.

[12] Ibidem.

Since the layer of limestone under consideration lies above the coal-bearing formation, all this difference of opinion as to the age of the latter affects directly the correlation of the limestone, which, from its position in the section, may be Oligocene just as well as Miocene.

Paleontological evidence is rather decidedly in favor of the Miocene as the age of the limestone. Foraminifera, the most important part of the fauna, are represented exclusively by so called smaller Foraminifera. The larger Foraminifera or, in general, forms typical of the Lower Tertiary, are absent completely. Although several species in the fauna are known also from the Lower Tertiary and even from the Cretaceous, these are forms of a wide vertical distribution appearing through the whole Tertiary and common in the recent seas. The most comparable foraminiferal faunas are, however, the Miocene ones of the New and Old Worlds, as will be shown in the following description of species in which the correlation is considered in detail when possible. Miocene faunas described from Northern Colombia, being chiefly macrofaunas, cannot be compared directly with the microfauna described in this paper, but they show a wide general distribution of the Miocene in Northern Colombia. Weisbord mentioned a great thickness of Miocene beds in the Atrata River Valley.[16] Quite

[13] Ibidem, p. 105.

[14] Ibidem, p. 335.

[15] Ibidem.

[16] Op. cit., p. 3.

possibly the Miocene of Northern Colombia penetrates into that valley and perhaps even is represented by the strata of which the fauna is described in this paper.

The specimen delivered to the writer was very rich in fossils. The described fauna, however, can hardly be considered as representing the typical fauna of this layer. Such a fauna could be brought together only with much more abundant material than that in the hands of the writer. Any attempt at more exact correlation or comparison of this fauna with some known Miocene fauna could not be therefore successful. Tentatively, the writer is ready to consider the fauna as rather closely related to the fauna of the Gatun Formation of the Panama Canal Zone.[17] *Lithothamnium colombianum* m., found among the animal fossils, gives strong support to such a correlation. As is mentioned in the description of this species, it is very similar and perhaps even identical with *Lithothamnium isthmi* Howe from the Emperador Limestone of the Panama Canal Zone, which represents the Uppermost Oligocene. In the rock specimen examined, this alga was found in the form of small pebbles rolled out by water, that is, in a secondary location of a later age than that of the Emperador Limestone. These conditions bring the correlation again toward the Miocene and the Gatun Formation.

DESCRIPTION OF THE ROCK SPECIMEN

The largest part of the examined rock was easily dissolved in cold hydrochloric acid with strong effervescence. After the latter has stopped, slight heating provokes it for a short time again. The acid extracts some Al, but very little Fe, although heating the rock fragments makes them brown. After the treatment with acid there always remains some amount of undissolved material. In the field the rock may be therefore called limestone, as it was indeed identified, but limestone which is slightly dolomized and in general impure.

The rock was analyzed at the Pittsburgh Station of the United States Bureau of Mines with the results given below.[18] Column I gives the original figures of the analysis. To obtain the figures in column II, a recalculation was made by the writer in such a way that all the moisture (0.9%), water (2.4%) and CO_2 (28.9%) were taken out, as well as the amount of CaO corresponding to that of CO_2. A part of the latter was combined in the rock with MgO, but this combination was neglected and the content of MgO left intact. The remainder (39.08%) was taken for 100 per cent and all components were recalculated accordingly.

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[17] Vaughan, Th. W., The biologic Character and geologic Correlation of the Sedimentary Formations of Panama in their Relation to the geologic History of Central America and West Indies: U. S. Nat. Mus. Bull. 103, p. 586. ff.

[18] The writer wishes to express his sincere gratitude to Dr. G. St. J. Perrott, Superintendent of the Pittsburgh Station of the Bureau of Mines, with whose permission the analysis was done at this Institution, and also to Dr. W. A. Selvig who analyzed the specimen.

	I	II
SiO_2	17.8	45.5
Al_2O_3	3.9	10.0
Fe_2O_3	3.0	7.7
FeO	1.4	3.6
CaO	38.2	23.8
MgO	1.8	4.6
Na_2O	0.3	0.8
K_2O	0.6	1.5
S	0.3	0.8
SO_3	0.1	0.3
CO_2	28.9	...
P_2O_5	0.58	1.5
Water	2.4	...
Moisture at 105°	0.9	...
	100.18	100.1

Microscopic examination of slides and sifted material discloses the psammitic nature of the rock, which is composed of pebbles, fragments of minerals and rocks, and numerous plant and animal microfossils bound together with calcareous cement. Rather numerous grains of quartz and a few of plagioclase are usually subangular as are lamellae of biotite. There is an abundance of small opaque pebbles, often well rounded, ball or ovoid shaped, and highly polished and brown, reddish, greenish, or black in color. Under a microscope it is possible in some of them to distinguish a few small grains of quartz. These pebbles remind one of felsite and felsitic ground-mass, or, speaking generally, devitrified ground-masses. Black or almost black pebbles with a greenish tint are, probably, composed of glauconite which also makes local irregular aggregates of a dirty green color and very often fills the chambers of foraminifers, shells of gastropods, etc., producing in this way, as always, very fine inner casts. Rough irregular grains remind one of lapilli. They often have a conchoidal glossy surface and may be of an obsidian nature. Besides pebbles and fragments of volcanic rocks, there are also a few fragments with small grains of pyrite, which originated probably from metamorphic rocks. There are abundant pebbles of calcareous algae as well as others, also calcareous, but structureless, although probably of organic origin as well.

Foraminifera in the fauna are usually well preserved, but minute gastropods are found only in the form of black inner casts. Often the fossils have been changed chemically. In this case shells are only partly affected by hydrochloric acid, which discolors the mineral substance filling or composing the shells, but does not destroy the fossils themselves.

The greatest part of the carbonate of lime found in this rock belongs to the fossils. Calcareous cement originated probably also from shells and calcareous algae. A rock of such character could be hardly called limestone. It is rather a calcareous sandstone of somewhat tuffoid character, because to a great extent it originated from volcanic ashes deposited on the bottom of the Miocenic Sea. It was probably a rather warm sea, as is shown by the great abundance of *Amphisteginae*, perhaps the most common foraminifer in the fauna. *Lithothamnia* are also mostly found in warm and shallow seas.[19] Since this alga was found in the form of pebbles, that is, in a secondary locality, the conclusions as to ecological conditions based on the presence of this alga refer to its primary locality. The locality was, apparently, not far from the shore of the sea. From this shore small polished pebbles and all psammitic materials were delivered to the deeper sea.

The microscopic character of the volcanic pebbles permits one to consider them as having originated from the ground-mass of dacites, a Tertiary volcanic rock very common in the Cordillera of Colombia. The rather abundant biotite in the examined specimen shows the possibility of relation with the biotite-amphibole dacite which, according to Küch,[20] is in Colombia the most common member of the dacite group. It may have been the original rock for ground-mass pebbles and fragments of plagioclase, biotite, etc.

The fact that the examined rock was partly of volcanic origin also gives some indication of its geological age, since the most important volcanic activity in the Cordillera occurred during the Upper Tertiary time and began in the Miocene.[21]

[19] Schenck, H. G., The biostratigraphic Aspect of the Micropaleontology: Jour. of Paleontology, II, 1928, p. 162.

[20] Küch, Richard, Die vulkanische Gesteine in W. Reiss und A. Stubel's Reisen in Süd-America, S. 50, Berlin, 1892.

[21] Steinmann, G., Geologie von Peru, SS. 208, 210. Heidelberg, 1929.

DESCRIPTION OF THE FAUNA

PISCES—TELEOSTEI

Family SCOMBRIDAE (?)

SCOMBRAMPHODON (?) Woodward

Scombramphodon (?) sp.

Plate XXXIX, figs. 1-6

Very small smooth teeth of an irregular conical form with a blunt rounded end. The root is broken off. Enamel white and transparent. The largest tooth (fig. 4) is 0.35 mm. long, two others are only a little over 0.3 mm. long.

It is hardly possible to find out, with any certitude, generic and even family relations of these interesting fossils which are unfortunately too incomplete for exact study. The writer prefers, however, to describe these remains under a quite tentative name, but not to leave them without any mention.

C. M. V. F. No. 5423-5425.

Scombramphodon (?) sp.

Plate XXXIX, figs. 7-10

Small smooth teeth with broken off roots are distinguishable from those described above by their size, which is about twice as great, elliptical cross section, and a triangular form a little different in the two present specimens. Enamel is of a greenish tint. The largest tooth (fig. 8) is 0.7 mm. long, the other one (fig. 10)—0.6 mm.

As in the previous case, identification is quite tentative here and these two teeth may even belong to an entirely different group of fishes.

C. M. V. F. No. 5426-5427.

CRUSTACEA—OSTRACODA

Family CYTHERELLIDAE

CYTHERELLA Jones

Cytherella atrata sp. n.

Plate XXXIX, figs. 11-14

The shell has an almost regular elliptical outline with the ventral border a little straighter than the hinge border. In the inner casts the ventral side is slightly concave. The horizontal section is more or less ovoidal with the greatest thickness a little in front of the center or about at the center of the shell. The larger right valve overlaps the left one all the way around with strongest overlapping on the hinge margin which is somewhat thickened. Contact line of both valves is a little undulating on the ventral border. Inner casts bear impressions of a strong central muscle. The surface of the shell is smooth with a few small irregularly distributed holes.

DIMENSIONS IN MM.

	Length	Height	Thickness
Complete specimen	0.7	0.5	0.3
An inner cast	0.7	0.5	0.3

This species is fairly closely related to *Cytherella reussii* J. & Sh.[22] from Bracklesham Beds of England (Eocene), but has its greatest thickness close to the middle of the shell and lacks therefore, in the edge-view, the lanceolate outline of the English species.

C. M. I. F. No. 6945-6946, 6989.

MOLLUSCA—GASTROPODA

Family TURBINIDAE

TURBO Linnaeus

Turbo sp.

Plate XXXIX, figs. 17-18

The shell has the form of a flat spiral of two rounded whorls, besides the innermost one which could be destroyed. Umbilicus shallow and wide. No sculpture is seen on the inner cast, except, perhaps some faint marks of growth.

In its general appearance this species corresponds to many *Turbinidae* with round whorls. The largest diameter 0.5 mm.

C. M. I. F. No. 6948.

Turbo sp.

Plate XXXIX, figs. 19-20

In general, this species corresponds to that described above, but has the whorls comparatively stouter, and umbilicus narrower and deeper than in the former. Besides that, it is a left-handed form. The largest diameter equals 0.4 mm.

C. M. I. F. No. 6949-6950.

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[22] Jones, T. Rupert and Sherborn, C. Davies, A Supplementary Monograph of the Tertiary Entomostraca of England: Monogr. Pal. Soc. London, 1889, p. 47, pl. II, figs. 4 and 8.

Turbo sp.

Plate XXXIX, figs. 21-24

A low turbinate, almost discoidal shell, probably of two round rather loose whorls increasing in size very gradually. Umbilicus rather narrow. The diameter of the largest specimen is over 0.4 mm. In one case can be seen the traces of transverse sculpture.

C. M. I. F. No. 6951-6953.

Turbo sp.

Plate XXXIX, fig. 25

The only specimen of a small *Turbo* (?). In general it is very similar to that described above, but distinguished from it by the left-handed coil and more rapidly enlarging whorls. The largest diameter is 0.3 mm.

C. M. I. F. No. 6954.

Family TROCHIDAE

TROCHUS Linnaeus

Trochus sp.

Plate XXXIX, figs. 15-16

A fragment of a small gastropod of a trochoid shape, composed of three incomplete whorls flattened from the periphery and making a low conical shell, with an apical angle of over 80°. The base was, apparently, flattened. The last whorl has remnants of sculpture consisting of transverse elliptical furrows, rather distant from each other. Height 0.2 mm., width 0.3 mm.

C. M. I. F. No. 6947.

Trochus sp.

Plate XXXIX, fig. 26

A conical shell composed of four gradually enlarging whorls slightly flattened from the periphery. Apical angle of about 50°. Umbilicus apparently absent. Aperture, probably, incomplete. No sculpture is noticeable on the inner casts. The most perfect specimen is 0.3 mm. in height of which 0.2 mm. corresponds to the spire. The width is 0.25 mm. Two other fragments belong to specimens more than twice as large.

In general shape and by its rounder whorls this form reminds one of *Hydrobia* sp. described below, but is distinguishable from it by the somewhat flattened whorls.

C. M. I. F. No. 6955-6956.

Family NATICIDAE

NATICA Lamarck

Natica sp.

Plate XXXIX, fig. 27

Shell somewhat compressed in a vertical direction, with the height about ⅔ of the width, composed of about four rounded whorls, the last of which is almost four times higher than the spire. The suture is very shallow, and the whorls are poorly separated from each other, as well as the last whorl from the spire. This gives the species a regular rounded shape. Aperture more or less ovoidal. Umbilicus, apparently, covered. No sculpture could be observed on the only inner cast present. Shell probably very thin. The greatest diameter 0.46 mm., the height over 0.3 mm.

C. M. I. F. No. 6957.

Natica sp.

Plate XXXIX, fig. 28

Shell of about the same height and width, 0.35 and 0.38 mm. respectively, composed of four whorls, the last one of which is about twice as high as the spire. Suture well expressed. Aperture apparently more or less ovoidal. Umbilicus very narrow or closed. No sculpture could be discovered.

To a certain extent this species corresponds in general appearance to some species of the genus *Amauropsis* Moerch. From three present specimens the smallest one is comparatively a little higher than the other two.

C. M. I. F. No. 6958-6959.

Natica sp.

Plate XXXIX, fig. 29

A left-handed shell composed of three ovoidal, laterally compressed whorls, the last of which occupies ¾ of the whole height of the shell. Umbilicus narrow. Suture rather deep. Surface apparently smooth. The largest diameter about 0.5 mm., the whole height about 0.4 mm., that of the last whorl 0.3 mm.

C. M. I. F. No. 6960.

Natica sp.

Plate XXXIX, fig. 31

Shell composed of three ovoidal whorls, not compressed laterally as in the previous species, and the shell thus having a somewhat different appearance. Suture rather deep. The surface presumably smooth. The largest diameter over 0.4 mm.

C. M. I. F. No. 6963-6964.

Family HYDROBIIDAE

HYDROBIA Hartmann

Hydrobia sp.

Plate XXXIX, fig. 30

Shell conical, composed of four or five round, gradually enlarging whorls. Apical angle about 40°. Umbilicus absent or very narrow. Aperture rounded, oval. The last whorl about 1.5 of the spire. No sculpture could be seen on the present inner casts. Probably, the shell was thin and smooth. The whole height of the best preserved specimen was about 0.7 mm., the spire about 0.25 mm., the width about 0.5 mm.

C. M. I. F. No. 6961-6962.

BRYOZOA—CYCLOSTOMATA

Family HETEROPORIDAE

HETEROPORA Blainville

Heteropora elliptica sp. n.

Plate XXXIX, fig. 32

The zoarium subcylindrical, apparently solid, more than 1.6 mm. thick. Apertures elliptical all more or less alike and about of the same size with the larger diameter of 0.2 mm., and the smaller one about one-half of the former. Walls between the apertures about 0.08 mm. thick, with small pores. Tubes apparently cylindrical, bent on the ends towards the periphery.

Typical for this species is the elliptical shape of apertures and their comparatively large size, both characters distinguishing it from *Heteropora tecta* Ulrich[23] with which the species under consideration has, in general, a rather close affinity.

C. M. I. F. No. 6965-6966.

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[23] Maryland Geological Survey, Eocene, Systematic Paleontology, Bryozoa by E. O. Ulrich, p. 210, pl. LIX, figs. 15, 16. 1901; comp. also Canu, F. and Bassler, R. S., North American Early Tertiary Bryozoa: U. S. Nat. Mus. Bull. 106, p. 682, pl. 104, figs. 14-20, 1920.

Heteropora sp.

Plate XXXIX, figs. 33-34

This form is represented only by fragments which do not give any idea about the general shape of the zoarium, but show some details of the inner structure. Apparently this form is closely related to *Heteropora elliptica* m., being perhaps only a variety of the latter. The only character distinguishing the two forms is the size of the tubes, the diameter of which in *Heteropora* sp. is about one-half of that observed in *Heteropora elliptica* m.

C. M. I. F. No. 6967-6968.

Heteropora sp.

Plate XXXIX, fig. 36

Zoarium small, massive, subramose with short thick branches rounded on the ends. Orbicular apertures, about 0.05 mm. in diameter or a little larger, distributed rather regularly over the whole surface of branches. Walls between apertures comparatively thick, about 0.05 mm.

This species is distinguished from both species of *Heteropora*, described above, by the general shape of the zoarium, by the circular apertures, and by the small diameters of the latter.

C. M. I. F. No. 6970-6971.

Heteropora (?) **amalgamata** sp. n.

Plate XXXIX, fig. 35

Zoarium small, apparently of low bushy shape composed of stout branches. Apertures orbicular, very small, with diameters not larger than 0.02-0.03 mm., distributed rather regularly over the surface of the zoarium, being more than 0.3 mm. distant from each other.

The surface of the walls between apertures is quite flat, which gives it a somewhat different appearance from other *Heteroporae* described above. *Heteropora amalgamata* m. is distinguishable also by its very small apertures which are twice as small as in the species of fig. 36, although for that species also are typical small apertures. The walls between the apertures are, however, comparatively thicker in this species than in the other ones.

C. M. I. F. No. 6969.

ECHINODERMATA

ASTEROZOA—ASTEROIDEA

Family ASTERIIDAE

ASTERIAS (?) Linnaeus

Asterias (?) **huntleyi** sp. n.

Plate XXXIX, figs. 37-49; pl. XLII, figs. 32-34

In the material under investigation there were found abundant, minute fossils the identification of which gave much trouble and which should be accepted *cum grano salis*. They are of a very variable shape, often irregular. However, they are grouped together because of their sculpture, which consists of small tubercles distributed, in most cases, rather irregularly and sparsely, but sometimes covering completely the given surface. Rarely the tubercles are distributed in rows and then cover the microscopical body all around. Usually, even when abundant, they cover only one side of the fossil. On the basis of their shape these fossils may be distributed in the following groups:

A. Figs. 37-39. Seed-like bodies of flattened ovoid form, 0.5–0.6 mm. long, or even a little longer. They taper toward both ends, but on the one have a neck-like joint a little hooked to one side which usually is tubercular and more flattened than is the other one. The latter sometimes bear tubercles, also, but usually in lesser number and distributed rather irregularly. Oftener this side is smooth or irregularly ribbed. The only interpretation which, in the writer's opinion, it is possible to offer for these fossils is to regard them as pedicellariae of sea stars, or, better to say, isolated jaws of pedicellariae. Since they have been found in such a fragmentary condition, it is very difficult to give their exact and complete description. Apparently they belonged to a so-called straight not crossed forcipiform (pincer-shaped) type and probably to the pedunculate one. They cannot be pedicellariae of *Echinoidea*, which are much more regular than those of *Asteroidea*. Certainly it would be hardly possible to identify, even generically, the star to which they could belong. The very common and widely distributed genus *Asterias L.*, known also in fossil forms, into association with which these remains have been brought, has abundant pedicellariae of this type. They are described as belonging to a new species on account of their sculpture which, being of a type common among sea-stars, does not appear in just such a form in any species known to the writer. The specific name is given in honor of L. H. Huntley, to whom the writer is obliged for this interesting specimen of limestone.

B. Figs. 40-43. Partially lenticular, rather thick bodies, covered on two surfaces with narrowly distributed tubercles. The lens is cut off on one side and bears here a shallow concavity divided by low ridges and tubercles. The shape of this concavity is such that it cannot be considered as other than the surface of a joint. Thus, all these bodies may be basal plates of pedicellariae. They are, however, comparatively large (1.0, 0.8, 0.9 mm.) and cannot be brought into direct connection with the pedicellariae described above. They may represent, however, basal pieces of crossed pedicellariae which are known in this genus, along with the straight ones.

C. Figs. 44-45. Plates bearing one rather large tubercle of varying structure. Some of them are low, located in the middle of the plate or anyhow some distance from its border and separated from the surface of the plate by a neck. Other tubercles are high, gradually confluent with the plate and located near its border. Tubercles of the first kind have a joint surface on the top and, probably, supported spines, pedicellariae not excluded. The second kind of tubercles may have been spines by themselves, although they also have a joint surface on the top. The surfaces of the plates themselves are usually smooth or bear a few isolated papillae, sometimes more abundant along borders.

D. Fig. 49. Fragments of spines roughly cylindrical or conical, rather irregular, bearing abundant or scarce tubercles distributed usually irregularly, or locally in rows. Along with the ornamented spines there are found a few smooth ones of different sizes, cylindrical or conical, slightly bent and then more or less bluntly ended or straight. They may be the dermal outgrows of star fishes.

E. Figs. 46-48. Plates of a rather irregular form with papillate sculpture. They are fragments and partly, probably, complete dermal plates of star fishes.

C. M. I. F. No. 6972-6988, 7074-7077.

HOLOTHUROIDEA

Family SYNAPTIDAE

CHIRIDOTA Eschscholtz

Chiridota (?) sp.

Plate XL, fig. 1

Only one specimen of a hook-like spicula, apparently not complete, corresponding very closely to the hook shaped spiculae of *Chiridota*,[24] although it is much larger and comparatively thicker than the latter. However, it is hardly possible to bring this small specimen into connection with any group of animals, except *Holothuroidea*. It is about 2.3 mm. long and 0.6 mm. thick in the thickest section.

C. M. I. F. No. 6990.

FORAMINIFERA

Family RHIZAMMINIDAE

BATHYSIPHON (?) M. Sars

Bathysiphon (?) sp.

Plate XL, figs. 2-3

Two small fragments of tubular form which may belong to the same specimen. General form subcylindrical, a little bent, and slightly tapering to one end. Walls are rather thick, 0.05 mm. on the section of 0.2 mm. diameter. Their supposed agglutinated structure could not be distinguished, which makes generic identification rather uncertain. The central channel is closed at the thick end, but apparently in a secondary way. The surface is smooth with inconspicuous and irregular annular contractions. The lengths of the two fragments are respectively about 0.8 and 0.6 mm., which brings the whole length to 1.4 mm. The diameter is over 0.3 mm. at the thicker end and over 0.2 mm. at the thinner one.

C. M. I. F. No. 6991-6992.

Family VERNEUILINIDAE

VERNEUILINA D'Orbigny

Verneuilina fusiformis sp. n.

Plate XL, figs. 4-5

Test free, bipyramidal, three-serial, the apical end rounded more bluntly than the basal one which is rather acute. The height and width are about equal, thus making outlines of the test rhombic, or the height is a little greater than the width. Transverse section triangular with rounded corners and somewhat inflated sides. Aperture, which could not be well observed, is apparently terminal and rounded. Surface smooth. Test is apparently calcareous through and through.

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[24] Bronn's Kl. und Ordn., Bd. II, Abth. 3, Buch 1, Taf. I, fig. 6. Review of fossil Holothuroidea is given by C. Croneis and J. McCormack, Journ. Pal., VI, pp. 111-148, pls. 15-21.

DIMENSIONS IN MM.

Height	Width
0.6	0.4
0.5	0.5

This species is distinguished from other species of this genus by its bipyramidal shape and by the cross-section which is more triangular than usual. At the same time it has rounded corners and could hardly be considered as belonging to the genus *Tritaxia* Reuss. Unfortunately the character of the aperture could not be well ascertained. Apparently it corresponds, perhaps, in structure more to the genus *Tritaxia* Reuss than to that of *Verneuilina* D'Orb. *sensu stricto.*

Verneuilina mexicana Nuttall[25] from the Lower Oligocene of Mexico reminds one, in its general shape, of the species under consideration.

C. M. I. F. No. 6993, 6995.

Verneuilina sp.

Plate XL, figs. 6-7

The only specimen of this form is distinguished from the *Verneuilina fusiformis* m. by its more cylindrical shape, almost round transverse section, relatively greater height and smaller general size. The height is about 0.43 mm., the width about 0.3 mm.

C. M. I. F. No. 6994.

Family MILIOLIDAE

QUINQUELOCULINA D'Orbigny

Quinqueloculina seminula Linnaeus

Plate XL, figs. 8-10

1767. *Serpula seminulum* Linnaeus, Systema naturae, Edition XII, p. 1264, No. 791.

1884. *Miliolina seminulum* Brady, Report on the Foraminifera dredged by H. M. S. Challenger during the years 1873-1876: Challenger's Report, Zoology, IX, p. 157, pl. V, figs. 6a-c, (Synonymy).

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[25] Nuttall, W. L. F., Lower Oligocene Foraminifera from Mexico: Journ. Pal., VI, p. 6, pl. 2, fig. 1-2, 1932.

1917. *Quinqueloculina seminulum* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 44, fig. 29, pl. 11, figs. 2a-b.

1918. *Quinqueloculina seminulum* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 78, pl. 27, figs. 4a-b; pl. 28; pl. 29, figs. 1a-e.

1921. *Quinqueloculina seminulum* Cushman, Foraminifera of the Philippine and adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 416, figs. 19-20, pl. 88, figs. 4a-c.

1922. *Miliolina seminulum* Protescu, Contribuţiuni la studiul faunei de Foraminifere terţiare diu România: Anuarul Institutului Geologic al României, IX, p. 296, Taf. III, fig. 3.

1929. *Quinqueloculina seminulum* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 6, p. 24, pl. 2, figs. 1a-c, 2a-c.

1929. *Quinqueloculina seminulum* Cushman, On *Quinqueloculina seminula* (Linné): Contr. Cushman Lab., V, p. 59, pl. 9, figs. 16, 17, 18a-c.

1930. *Quinqueloculina seminulum* Cushman & Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 10, pl. 1, figs. 8a-c.

1930. *Quinqueloculina seminulum* Cushman & Cole, Pleistocene Foraminifera from Maryland: Contr. Cushman Lab., VI, p. 95, pl. 13, figs. 1a-c.

1930. *Quinqueloculina seminulum* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 19, pl. 2, figs. 1a-c.

1931. *Quinqueloculina seminulum* Kornfeld, Recent littoral Foraminifera from Texas and Louisiana: Contr. Dept. Geol. Stanford Univ., I, p. 83, pl. 14, figs. 4a-c.

1933. *Quinqueloculina seminulum* Cushman & Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 9, pl. 2, figs. 2a-c.

Test longer than wide, ovoidal with greatest width near the middle. Chambers of almost uniform thickness with rounded periphery, well separated from each other by distinct sutures. Wall smooth and shiny. Aperture rather large with a simple thin, rather long tooth. Apertural end apparently not protruding, although its truncation cannot be observed well in Colombian forms because their last chamber is usually broken off. The average length is over 0.5 mm.

Under this specific name are included so many different forms of smooth *Quinqueloculinae* that, in Cushman's opinion, it would be unwise to attempt to give a detailed synonymy for this species.[26] Referring to Brady's description, Cushman points out that the text figures in the Challenger report, representing this species, show very different forms and adds "The synonyms are probably numerous, but hardly as many as indicated by Brady."[27] The correctness of Brady's identification is also questioned by Galloway and Wissler[28] in whose opinion *Miliolina seminulum* L. described by Brady is *Quinqueloculina akneriana* D'Orb. This view is shared by Thalmann[29] as well as Cushman and Stewart.[30] According to both last authors, *Quinqueloculina akneriana* D'Orb. is "somewhat shorter and more rounded" than the closely related *Quinqueloculina seminula* L. The latter species also was revised by Cushman who had an opportunity to visit the locality from which Linne's species had been obtained and to collect there abundant new material. According to Cushman "The name *Quinqueloculina seminula* L. should be applied to the smooth quinqueloculine form, with rounded or very slightly angled chambers, with a truncated apertural end, and the aperture with a simple tooth."[31] The new specimens figured by him correspond very closely to those given by Brady in their general shape and dimensions; in both cases the relation between the length and width is about 1.6, while for *Quinqueloculina akneriana* D'Orb. it equals 1.3. Since this difference is the most important character distinguishing the two species, it is hardly advisable to bring *Quinqueloculina seminula* L. described by Brady into association with *Quinqueloculina akneriana* D'Orb. or to include the latter species in the synonymy of the former. Colombian forms correspond very well to Cushman's definition of the species under consideration and have the same (1.6) relation between their length and width. As was mentioned, however, the truncated apertural end could not be observed well on account of the fragmentary condition of the specimens. This character appears to be of great importance because forms with an exserted apertural end described formerly as *Quinqueloculina seminula* L., for example, by Stadnichenko[32] or

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[26] U. S. Nat. Mus. Bull. 104, part 6, p. 25.

[27] Contr. Cushman Lab., V, p. 60.

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[28] Galloway, J. J. and Wissler, S. G., Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal., I, p. 38.

[29] Thalmann, H. E., Nomeclator (Um- und Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk uber die Foraminiferen der Challenger-Expedition, London, 1884: Ecl. Geol. Helvetiae, XXV, p. 296, 1932.

[30] Cushman, J. A. and Stewart, R. E. and K. C., Tertiary Foraminifera from Humbold County, California, A preliminary Survey of the Fauna: Trans. San Diego Soc. Nat. Hist., VI, p. 52, 1930.

[31] Contr. Cushman Lab., V, p. 60.

[32] Stadnichenko, M. M., The Foraminifera and Ostracoda of the marine Yegua of the Type Sections: Journ. Pal., I, p. 226, pl. 38, fig. 28, 1927.

Berry and Kelley[33] are separated now under a new specific name of *Quinqueloculina yeguaensis* Weinzierl & Applin.[34] There is also some doubt as to the real character of the apertural tooth. In his definition of the species quoted above, Cushman mentioned "a simple tooth," but in his fig. 18c, accompanying the description, the tooth becomes slightly bifid at the free end. The same discrepancy between description and figures is found in Cushman and Cahill's monograph of Miocene Foraminifera of the Coastal Plain,[35] but figures correspond to description in the monograph of the Foraminifera of the Atlantic Ocean.[36]

This species is widely distributed in waters of the Atlantic and the Pacific Oceans, chiefly in their northern sections, where often it is larger than forms of more southern areas. It is apparently absent in tropical waters.[37] Its vertical distribution is also very great as it was found in shallow waters and as deep as 3,000 fathoms.[38] Geologically, this species, appearing through the whole Tertiary, is, in general, particularly important in the Miocene and the Upper Tertiary. In Europe it was found abundantly in the Miocene of the Vienna Basin, in Rumania, etc., also in the Miocene of Egypt.[39] It is comparatively rare in the Choctawhatchee of Florida, but very abundant in the Miocene of Maryland, less so in the Miocene of Virginia. In the Panama Canal Zone it was found in the Culebra Formation, in the Gatun Formation, and also in the Pleistocene.

C. M. I. F. No. 6996-6999.

Quinqueloculina auberiana D'Orbigny

Plate XLII, figs. 35-36

1840. *Quinqueloculina auberinana* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba par D. Ramon de la Sagra, p. 167, lam. XII, figs. 1-3.

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[33] Berry, W. and Kelley, L., The Foraminifera of the Ripley Formation on Coon Creek, Tennessee: U. S. Nat. Mus. Proc., 76, art. 19, p. 16, pl. 2, figs. 11-12, 1929.

[34] Weinzierl, L. L. and Applin, E. R., The Clairborne Formation on the Coastal Domes: Journ. Pal., III, p. 393, pl. 44, figs. 4a-b, 1929.

[35] U. S. G. S. Prof. Paper 175-A, p. 9.

[36] U. S. Nat. Mus. Bull. 104, part 6, p. 24.

[37] Ibidem, p. 25.

[38] Brady, op. cit., p. 160.

[39] Macfadyen, W. A., Miocene Foraminifera from the Clysmic Area of Egypt and Sinai: Geol. Survey of Egypt, p. 44, Cairo, 1930.

1884. *Miliolina auberiana* Brady, Report on the Foraminifera dredged by H. M. S. Challenger during the years 1873-1876: Challenger's Report, Zoology, IX, p. 162, pl. V, figs. 8a-c, 9.

1912. *Miliolina auberiana* Bagg, Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 26, pl. IV, figs. 2a-b, (Synonymy).

1918. *Quinqueloculina auberiana* Cushman, The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 79, pl. 29, figs. 3a-c.

1918. *Quinqueloculina auberiana* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 23, pl. V, figs. 3a-c; p. 71, pl. XXX, figs. 1a-c.

1930. *Quinqueloculina lamarckiana* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 20, pl. 2, figs. 3a-c, 4a-b, 5a-c.

1930. *Quinqueloculina lamarckiana* Cushman and Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 10, pl. 1, figs. 9a-c, 10a-c; pl. 2, figs. 2a-c.

1933. *Quinqueloculina lamarckiana* Cushman and Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 9, pl. 2, figs. 4a-c, (Synonymy).

Test slightly longer than broad or about equally as long as broad. Chambers distinctly triangular in cross section with angled periphery easily distinguishable even in inner casts. Sutures somewhat depressed, distinct. Apertural end neither exsert, nor truncated. Wall smooth. One complete specimen is 0.5 mm. long, 0.4 mm. wide, and 0.3 mm. thick.

The Colombian form corresponds very closely to D'Orbigny's species in the shape of its chambers, acutely angled periphery, smooth surface, general shape, and the relation of the different dimensions. There is, however, some question as to which specific name might be used properly for this form. Cushman, who had used at first the name of *Quinqueloculina auberiana* D'Orb. substituted for it, in 1922, the name of *Quinqueloculina lamarckiana* D'Orb. He considered the two species to be identical and thought the latter one had the text priority,[40] as it had been described by D'Orbigny four pages ahead and figured on the preceding table to that of *Quinqueloculina auberiana* D'Orb. A comparison of original figures of the two species shows, however, a very distinct although small difference between them. *Quinqueloculina lamarckiana* D'Orb. has an exsert apertural end in the form of a short neck which *Quinqueloculina auberiana* D'Orb. lacks. The same character brought the separation of *Quinqueloculina yeguaensis* W. & A. from *Quinqueloculina seminula* L., and it may be considered sufficient to keep apart the two forms under consideration, both with angled periphery. Apparently Thalmann[41] is of the same opinion, since he mentions separately both *Quinqueloculina auberiana* D'Orb. and *Quinqueloculina lamarckiana* D'Orb.

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[40] Cushman, J. A., Foraminifera from the north coast of Jamaica: U. S. Nat. Mus. Proc. 59, No. 2360, p. 66.

Quinqueloculina auberiana D'Orb. is a common recent species of the littoral shallow water of tropical seas. Geologically, Brady considered as probable its existence in the Miocene of the Vienna Basin. Bagg accepted its geological range as being from the Miocene up to the present time. At the Panama Canal Zone it was described from the Pleistocene. From Pliocene and Miocene it was described from a number of localities of the Coastal Plain of the United States. In Colombia it was mentioned, although with some reservations, by Church,[42] from the lowest horizon M-N of the Tubera Group, that is, from the Lower Miocene.

C. M. I. F. No. 7072, 7078.

Quinqueloculina subquadrata sp. n.

Plate XLII, figs. 30-31

Test small, of almost square outlines, on the average about 0.25 mm. long and broad. Chambers rounded, not very distinct on account of shallow sutures. Periphery rounded. Apertural end somewhat truncated. Wall smooth.

This form is distinguished from other *Miliolidae* of the fauna by its small size and square outlines. *Quinqueloculina wadei* Berry[43] reminds one somewhat of the Colombian form, but has a more circular form than the latter.

C. M. I. F. No. 7073, 7079.

Family LAGENIDAE—NODOSARIINAE

LENTICULINA Lamarck

Lenticulina rotulata Lamarck

Plate XL, figs. 11-12

1806. *Lenticulites rotulata* Lamarck, Suite des mémoires sur les fossiles des environs de Paris: Ann. Mus. Hist. Nat. VIII, p. 188, pl. 62, fig. 11.

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[41] Op. cit., p. 296.

[42] Anderson, F. M., Marine Miocene and related Deposits of North Colombia: Proc. Cal. Acad. Sc., IV Ser., XVIII, p. 179, 1929.

[43] Berry, W. and Kelley, L., The Foraminifera of the Ripley Formation on Coon Creek, Tennessee: U. S. Nat. Mus. Proc., 76, art. 19, p. 17, pl. 2, figs. 4-5.

1918. *Cristellaria rotulata* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 60, pl. 22, fig. 1, (Synonymy).
1923. *Cristellaria rotulata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 4, p. 108, pl. 28, figs. 1, 2.
1924. *Cristellaria rotulata* Hanna, G. D. and M. A., Foraminifera from the Eocene of Cowlitz River, Lewis County, Washington: Univ. Washington Publ. in Geology, I, No. 4, p. 61, pl. XIII, figs. 14, 19, 20.
1926. *Cristellaria rotulata* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 91, pl. VII, figs. 8a, b.
1927. *Lenticulina rotulata* Cushman, Notes on the Collection of Defrance: Contr. Cushman Lab. III, p. 142, pl. 28, fig. 7a-b.
1927. *Cristellaria rotulata* Stadnichenko, The Foraminifera and Ostracoda of the marine Yegua of the Type Sections: Journ. Pal. I, p. 228, pl. 38, figs. 12, 13, 29.
1931. *Lenticulina rotulata* Hanzawa, On some Miocene Rocks with Lepidocyclina from the Izu and Bôsô Peninsulas: Sc. Rept. Tahoku Imp. Univ., 2nd Ser. (Geology), p. 167, pl. II, figs. 15-16, (Synonymy).

Cristellaria rotulata Lamarck belongs to the most common Foraminifera having a very wide geographical, bathymetrical and geological distribution. It is found in the Arctic and in the tropics, in shallow water and as deep as 2,200 fathoms, and, beginning with the Upper Trias, occurs through all overlaying strata, being particularly abundant in the Tertiary where it has been discovered in almost every locality where a foraminiferal fauna[44] occurs. Accordingly, the synonymy of the species became so voluminous that, for example, Bagg finds it "too cumbersome to be given in full."[45] It is possible, however, that such a wide distribution is more apparent than real. As used to happen practically to all old species, the name of *Lenticulina rotulata* Lamarck was applied often rather indiscriminately to the forms which should be considered at least as good varieties of this species. Such varieties were mentioned, for example, from the Pliocene of California by Bagg.[46] Cushman, who found and reproduced Lamarck's type,[47] came to the conclusion that the typical form of this species is "restricted to the Upper Cretaceous of various parts of the world."[48] "Very many of the records for the species from Recent seas and from Tertiary deposits do not belong to the species, however" says he in another place in reference to this species.[49] As a result of all those remarks and criticisms there have been established lately many new species of Lenticulina which formerly would have been brought into association with *Lenticulina rotulata* Lamarck.

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[44] Brady, H. B., Op. cit., p. 548.

[45] Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 38, 1905.

[46] Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 67, 1912.

[47] Contr. Cushman Lab., III, l. c.

[48] Cushman, J. A., Cretaceous Foraminifera from Antigua, B. W. I.: Contr. Cushman Lab. VII, p. 37, 1931.

In the present paper this name is applied only to small *Cristellariae* tests of which are composed of seven or eight chambers. Their peripherial margin is acute, but without a distinct keel. Sutures, sometimes rather indistinct, are almost straight and bent only a very little. The central part is filled with the shell substance, not protruding, however, in the form of a plug, but following the general curvature of the surface. Diameter of the figured form over 0.4 mm., thickness about 0.3 mm.

The synonymy given above refers only to the Tertiary and Recent varieties corresponding to the form under consideration. From most of them the later is distinguishable generally by its much smaller size and by its central part, which is more confluent with the general surface of the test than usually shown on the quoted figures. In this respect some Cretaceous forms, as for example, those figured by Cushman from Coalinga[50] or by Plummer from Texas,[51] are much nearer to the Colombian form than the Tertiary ones. Among Tertiary forms, one very closely related is the variety from the Midway Formation of Texas.[52]

Only a few specimens of this species were found and it should be considered rare in the Colombian Miocene, as it is, indeed, in several other localities. For example, according to Bagg, "The species is exceedingly rare in the California Miocene"[53] as well as in the California Pliocene.[54] Stadnichenko,[55] who described this form from different localities of the Yegua Beds of Eastern Texas, found it everywhere rare or even extremely rare. On the contrary, according to Cushman, it "seems to be the commonest species in the Panamanian material."[56] It was found there in the lower part of the Culebra formation and in the Gatun Formation. Hanzawa also considers this form as common geologically, as widely distributed in the present time.[57]

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[49] Cushman, J. A. and Church, C. C., Some Upper Cretaceous Foraminifera from near Coalinga, Cal.: Proc. Cal. Acad. Sc., IV Ser, XVIII, p. 503, 1929.

[50] Ibidem, p. 503, pl. 37, figs. 1-2.

[51] Plummer, H. J., Some Cretaceous Foraminifera in Texas: Univ. Texas Bull. 3101, p. 142, pl. XI, fig. 20, 1931.

[52] Plummer, H. J., Univ. Texas Bull. 2644.

[53] Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 38, 1905.

[54] Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 67, 1912.

[55] l. c.

C. M. I. F. No. 7000-7001.

Lenticulina colombiana sp. n.

Plate XL, figs. 14-15.

Test comparatively large, lenticular, regularly biconvex, involute. Periphery has a sharp edge, but no distinct keel. Wall smooth. Umbilicus absent. Sutures are limbate, slightly curved and extend to the center. They separate thirteen chambers in the last whorl. The length of the only complete specimen is 2.7 mm. (the diameter perpendicular to the length is 2.4 mm. long), the thickness 1.3 mm.

This species reminds one of the Tertiary forms of *Lenticulina rotulata* Lam., of about the same size and with as many chambers,[58] also of different related forms described, for example, by Cushman from the Atlantic Ocean.[59] The species under consideration is distinguishable from all of them by limbate sutures reaching to the center of the test and by the absence of an umbilicus.

C. M. I. F. No. 7003-7004.

Lenticulina lens sp. n.

Plate XL, figs. 16-17

Test rather small, but thick, regularly lenticular, strongly involute, composed of eight chambers. Periphery angled, but not keeled. Sutures slightly curved, thick, and a little depressed. Umbilicus large, but filled with the transparent shell substance which, however, does not protrude above the surface of the test. Surface smooth. Diameter about 1.4 mm., thickness 0.7 mm.

This species appears to be quite closely related to *Lenticulina rotulata* Lam. described above, but the latter is smaller than this species, its sutures are hardly seen through the shell, and the middle part of the test protrudes in the form of a boss.

C. M. I. F. No. 7005.

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[56] l. c.

[57] l. c.

[58] Brady, H. B., Op. cit., p. 547, pl. LXIX, figs. 13a-b.

[59] U. S. Nat. Mus. Bull. 104, part 4.

Lenticulina multiseptae (?) **Berry**

Plate XL, fig. 13

1928. *Cristellaria multiseptae* Berry, The Foraminifera of the Restin Shale of Northwest Peru: Ecl. Geol. Helvetiae, XXI, p. 132, fig. 2. Basel.

One incomplete specimen of a *Lenticulina* is distinguished from the other species of the genus by numerous slightly protruding and curved sutures, the number of which is not less than fifteen. The umbilical part is somewhat raised. Diameter about 1.1 mm. Thickness 0.7 mm.

This form reminds one very strongly of *Lenticulina multiseptae* Berry, described from the Lobitos formation (Middle Eocene). However, the poor condition of the only specimen found and the schematic nature of the figure given by Berry do not permit one to consider the above identification other than tentative.

C. M. I. F. No. 7002.

Lenticulina orbicularis D'Orbigny

Plate XL, figs. 18-19

1826. *Robulina orbicularis* D'Orbigny, Tableau méthodique de la classe des céphalopodes: Ann. Sc. Nat. VII, p. 288, figs. 8-9.
1926. *Cristellaria orbicularis* Plummer, Foraminifera of the Midway Formation of Texas: Univ. Texas Bull. 2644, p. 92, pl. VII, figs. 1a-b, (Synonymy).
1928. *Cristellaria orbicularis* Nuttall, Tertiary Foraminifera from the Naparina Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 86, pl. V, fig. 4.

Test composed of long narrow chambers making sweeping curves terminating in the central umbo. Periphery extended and angulated, making a well defined keel. Sutures somewhat raised and slightly limbate. The figured specimen has a diameter of over 0.9 mm. and is over 0.5 mm. thick.

This species has been found in warm and cold zones of the Atlantic and Pacific Oceans, mostly in rather deep water, although it also occurs at a depth of only 38 fathoms. Fossil it was described in the Subappenine formations of Central Italy (Pliocene), in the Miocene of the Vienna Basin, in the Midway Formation of Texas where it is abundant in the upper part of the formation. It was described also from the so-called Upper Series of the Trinidad Tertiary.[60]

C. M. I. F. No. 7006-7007.

[60] Nuttall, l. c.

ROBULUS Montfort

Robulus lenticularis sp. n.

Plate XL, figs. 20-21

Test small, thick, closely coiled, completely involute, sharp on the edge, but without a keel. Surface white, porcellaneous, perfectly smooth, without any trace of septa on the surface. The chambers, numbering seven or eight to a whorl, could hardly be differentiated through the opaque wall. Aperture in the form of an elongate slit, typical for the genus. The figured specimen is about 0.6 mm. in diameter (a little over 0.6 mm. in one direction and little less than that in another). The thickness is over 0.3 mm.

The small size, regular lenticular shape, and smooth porcellaneous opaque wall characterize this species sufficiently as a new one.

C. M. I. F. No. 7008-7009.

DENTALINA D'Orbigny

Dentalina pauperata D'Orbigny

Plate XL, figs. 22-23

1846. *Dentalina pauperata* D'Orbigny, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche), p. 46, pl. I, figs. 57, 58, Paris.[61]

1913. *Nodosaria pauperata* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 3, p. 51, pl. 25, fig. 7, (Synonymy).

1922. *Dentalina pauperata* Protescu, Contribuţiuni la studiul faunei de foraminifere terţiare din România: Anuarul Institutului Geologic al Rumâniei, IX (1919-1920), p. 320, Tab. I, fig. 16.

1923. *Dentalina pauperata* Hanna, Some Eocene Foraminifera near Vacaville, California: Univ. California Publ. in Geol. Sc. XIV, No. 9, p. 322, pl. 58, figs. 3a-b, 5.

1929. *Dentalina pauperata* Cushman, A Late Tertiary Fauna of Venezuela and other related Regions: Contr. Cushman Lab., V, p. 85, pl. 12, figs. 23, 24.

1931. *Dentalina pauperata* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 99, pl. 10, figs. 11, 12.

An incomplete slightly arcuate specimen composed of five full chambers having about the same height and diameter but slightly tapering to one end. The earlier chambers are more cylindrical than the latter one, which is somewhat inflated. Sutures, therefore, are shallower in the early portion of the test than in the later one. Aperture round, central. Surface smooth with a few low, rather inconspicuous tubercles irregularly distributed over the surface. The length of the fragment is about 0.8 mm., diameter of the last chamber about 0.2 mm.

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[61] Reproduced in Galloway's Plates of Foraminifera, V, p. 68.

This form is really cosmopolitan in present seas and is found in very different conditions from the near-shore habitat down to depths of 2,000-3,000 fathoms.[62] It has, also, a very wide geological range. Beginning with the Permian, it can be found in sediments of practically every later age. Originally, the species was described from the Miocene of Vienna, and is also known in the Miocene of Rumania. In the Miocene it was also found in California,[63] in Ecuador, Venezuela and Trinidad.[64] In California it was described by Hanna from the Eocene also.[65]

C. M. I. F. No. 7010.

Dentalina sp.

Plate XL, fig. 25

Two incomplete longitudinal sections belonging to the same species, the best of which, composed of six chambers, is figured. It tapers slightly to one end and is a little arcuate. Chambers of more spherical than cylindrical shape. The wall is rather thick. Apertures round, with short neck located a little excentrically. The length of the fragment 2.4 mm., the greatest diameter 0.6 mm.

On account of poor preservation, this form cannot be identified specifically. It is distinguished from two other *Dentalinae* in the fauna under consideration by the larger size and more spherical shape of the chambers. A longitudinal section of *Dentalina* sp. indet. from the Japanese Miocene[66] reminds one very much of the vertical section of the form under consideration.

C. M. I. F. No. 7012-7013.

Dentalina sp.

Plate XL, fig. 24

A cylindrical slightly arcuate fragment tapering very little to the lower bluntly rounded end. Four and one-half chambers preserved in the fragment are of cylindrical shape with the height a little less than the diameter and have very shallow hardly conspicuous sutures.

[62] Brady, H. B., Op. cit., p. 501.

[63] Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 322, pl. V, fig. 8, also J. A. Cushman and B. Laiming, l. c.

[64] Cushman, J. A., 1929, l. c.

[65] l. c.

[66] Hanzawa, Sh., On some Miocene Rocks with Lepidocyclina from the Izu and Bôsô Peninsulas: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XII, No. 2A, p. 170, pl. XXVIII, fig. 17, 1931.

Surface smooth, slightly corroded. Length of the fragment about 0.8 mm., thickness 0.3 mm.

Nodosaria obliqua L. described by Cushman[67] from the Miocene of California, or at least the lower part of the test, is very similar to the form under consideration. So far as it is possible to judge from the description and figures, the Californian form is different from the Linnean species. *Dentalina communis* D'Orb. from different localities is also very similar to the form under consideration, as is shown by comparison with a form described from the Miocene of the Coastal Plain.[68]

C. M. I. F. No. 7011.

Family NONIONIDAE

ELPHIDIUM Montort.

Elphidium crispum Linnaeus.

Plate XL, figs. 26-27

1767. *Nautilus crispus* Linnaeus, Systema Naturae, 12 ed., p. 1162.

1914. *Polystomella crispa* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 32, pl. 18, figs. 1a, b. (Synonymy).

1918. *Polystomella crispa* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 76, pl. 27, figs. 2a, b.

1918. *Polystomella crispa* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 69, pl. XXVII, figs. 1, 4, 5.

1920. *Polystomella crispa* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Paper. 128-B, p. 71, pl. XI, fig. 19.

1924. *Polystomella crispa* Van der Vlerk, Foraminiferen uit Het Tertiair van Java: Wetenschappelijke Mededeelingen, No. 1, p. 24, pl. V, fig. 28, 29, Weltevreden.

1927. *Themean crispus* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 82, pl. 12, figs. 17a, b.

1927. *Elphidium crispum* Cushman & Grant, Late Tertiary and Quaternary Elphidiums of the West Coast of North America: Trans. San Diego Soc. Nat. Hist., V, No. 6, p. 73, pl. 7, figs. 2a-b, 3a-b.

1929. *Elphidium crispum* Cushman & Leavitt, On *Elphidium macellum* (Fichtel & Moll), *E. striato-punctatum* (Fichtel & Moll) and *E. crispum* (Linné): Contr. Cushman Lab. V, p. 20, pl. 4, figs. 3a, b, 4a, b.

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[67] Cushman, J. A., Foraminifera of the typical Monterey of California: Contr. Cushman Lab., II, p. 56, pl. 7, fig. 5, 1926.

[68] Cushman, J. A. and Cahill, E. D., Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 14, pl. 5, fig. 2, 1933.

1929. *Polystomella* cfr. *crispa* Comerci, Di alcuni foraminiferi terziari dell' isola di Borneo: Boll. Soc. Geol. Ital., XLVII, p. 145, Tav. VIII, fig. 9.

1930. *Elphidium crispum* Cushman & Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 21, pl. 5, figs. 12a-b.

Test bilaterally symmetrical, rather thick with the relation of the diameter to the thickness about 3:2, composed of twenty chambers in the last-formed coil. Periphery sharply angular. Umbilical region slightly convex, being filled up with clear shell material. Its diameter about $\frac{1}{6}$ of that of the test. Sutures are raised and somewhat limbate, but narrower than the bridged areas. Diameter of the figured specimen 0.4 mm., thickness 0.26 mm. Diameter of another specimen should be over 0.5 mm. Colombian specimens are distinguished from the typical form only by their relatively greater thickness.

Elphidium crispum L. is one of the most abundant, recent, shallow-water Foraminifera. It is also very common through the whole Tertiary, as well as in the Pleistocene. In the Panama Canal Zone it was found in the Gatun Formation. It is abundant in the Miocene of the Coastal Plain, especially in the Choctawhatchee and Chipole marls of Florida and in the Duplin marl in the Carolinas. It is also very common in the Pliocene and Pleistocene of California[69] and is known in the Lower Miocene of Java and Borneo and in many Tertiary localities of Europe, from which it was first described. From the west coast of North America it was mentioned by Cushman and Grant from a great number of Pliocene and recent localities. Particularly close to the Colombian form is the small variety from the Pleistocene of Magdalena Bay, Lower California, Mexico, and found as a recent form at Carmen Island, Gulf of California, Mexico.[70] In the fauna under consideration it is rare, being represented by only three specimens.

C. M. I. F. No. 7014-7015.

Family BULIMINIDAE (TURRILININAE)

BULIMINELLA Cushman

Buliminella pulchra sp. n.

Plate XL, fig. 28

Test regularly spiral, of three volutions, the last of which occupies about three-fourths of the whole height of the test. Sutures well marked between the last whorl and the previous one, rather indistinct in earlier stage. The final whorl has five or six chambers separated from each other by distinct sutures. Surface shining, smooth. Aperture elongate, slightly curved. Length about 0.3 mm., the greatest thickness about 0.2 mm.

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[69] Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 90, pl. XXVII, figs. 13-20, XXVIII, figs. 1-6.

[70] Cushman, J. A. and Grant, IV, U. S., l. c.

This species is represented in the fauna by only one specimen, but this one is so well preserved that its description does not afford any difficulty. *Buliminella turbinata* Terq. from the Eocene of Paris[71] is very closely related to this one under consideration. Particularly it concerns the form represented on fig. 6 of Terquem's paper. The European form, however, has apparently more chambers in the last whorl than the American one. The other variety (Terquem's fig. 7) has less chambers than the first one, in this respect being more closely related to the Colombian form, but is more slender than the latter. Besides that, both European varieties have a rather round aperture. Also very closely related in its general shape is *Buliminella colonensis* Cushm. & Hedb. from the Colon Shale (Upper Cretaceous) of Venezuela.[72] The author's words: "This is really a unique species in its very broad form with the last formed coil occupying most of the area of the test," and also: "In some respects the species resembles Rotaliatina," may be applied to the species under consideration as well. The last coil of the Venezuelan form is, however, comparatively still larger than in *Buliminella pulchra* m. *Rotaliatina mexicana* Cushman,[73] the form most similar to these two *Buliminellas*, is stouter, has shallower sutures, and is, therefore, more or less ovate.

C. M. I. F. No. 7016.

BULIMINA D'Orbigny

Bulimina affinis D'Orbigny

Plate XL, fig. 29

1840. *Bulimina affinis* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba par D. Ramon de la Sagra, p. 109, lam. II, figs. 25 y 26.

1922. *Bulimina affinis* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 3, p. 103, pl. 20, fig. 6, (Synonymy).

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[71] Terquem, M., Les Foraminifères de l'Eocene des Environs des Paris: Mém. Soc. Géol. France, Ser. III, T. II, p. 113, pl. XII, figs. 6-7, Paris, 1882. Reproduction in Galloway's Plates of Foraminifera, VI, p. 117.

[72] Cushman, J. A. and Hedberg, H. D., Notes on some Foraminifera from Venezuela and Colombia: Contr. Cushman Lab., VI, p. 65, pl. 9, figs. 6-7, 1930.

[73] Cushman, J. A., New Foraminifera from the Upper Eocene of Mexico, Contr. Cushman Lab., I, p. 4, pl. I, figs. 1a, b, c. 1925.

1926. *Bulimina* sp. ? Cushman & Applin, Texas Jackson Foraminifera: Bull. Am. Asso. Pet. Geol., X, p. 169, pl. 7, figs. 10, 11.

1927. *Bulimina affinis* Franke, Die Foraminiferen und Ostracoden des Palaeocäns von Rugaard in Jütland und Jundkragen bei Kopenhagen: Danmarks geologiske Undersøgelse, II Raekke, No. 46, S, 11. Taf. I, Fig. 9, Kjøbenhavn.

1928. *Bulimina affinis* Nuttall, Tertiary Foraminifera from the Naparima Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 77, pl. III, fig. 6.

1931. *Bulimina brevis* Cushman, Cretaceous Foraminifera from Antigua, B. W. I.: Contr. Cushman Lab., VII, p. 40, pl. 5, figs. 9a-c.

1932. *Bulimina bicona* Berry, The Foraminifera of the Heath Formation of Northwestern Peru, South America: Ecl. Geol. Helvetiae, XXV, No. 1, p. 28, pl. III, figs. 13, 14.

Test conical, tapering from the broadly rounded apertural end toward the bluntly pointed apical one. Inflated chambers separated by well expressed sutures are arranged in three not very regular series. Wall smooth. Height of only specimen found over 0.4 mm., maximal thickness about 0.3 mm.

Brady described *Bulimina affinis* D'Orb.[74] along with *Bulimina ovata* D'Orb. and *Bulimina pupoides* D'Orb. as three varieties of the same species (*Bulimina affinis* D'Orb.) which cannot be separated from each other even as subspecies. However, *Bulimina affinis* D'Orb. is well distinguished from the two other species by its acuminate apical end, obovate apertural end, and by its apparently greater thickness. *Bulimina ovata* D'Orb. has the ends bluntly rounded and is broadly oval. *Bulimina pupoides* D'Orb. has an intermediate position between the two other species. In the recent paleontological literature all three names are used specifically, but often somewhat vaguely. It is not surprising, since the distinctive characters are variable and there are intermediate forms between the three species. A form described by Cushman from the Jackson Beds of Texas corresponds apparently very closely to *Bulimina affinis* D'Orb., but *Bulimina* sp. described by Cushman from the Eocene of the Moctezuma River[75] to which he refers in his description of the Texas form looks different. Judging from figures, *Bulimina brevis* D'Orb. described by Cushman from the Cretaceous of Antigua is nearer to *Bulimina affinis* D'Orb. than the species from Mexico. To a certain extent Cushman's description of this form supports this conclusion.

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[74] Brady, H. B., Op. cit., p. 400, pl. L. figs. 13-15. To *Bulimina affinis* D'Orb., sens. str., refer figs. 14a-b.

[75] Cushman, J. A., An Eocene Fauna from the Moctezuma River, Mexico: Bull. Am. Asso. Pet. Geol. IX, p. 301, pl. 7, fig. 9, 1925.

He considers his *Bulimina brevis* D'Orb. as identical with *Bulimina ovula* Reuss, and the latter is identical, according to Brady,[76] with *Bulimina affinis* D'Orb. Figures of the original *Bulimina brevis* D'Orb. show a different form.

Bulimina affinis D'Orb., like the two other related species, is found abundantly in recent seas, Pliocene and in the whole Tertiary, but unlike them it goes down into the Cretaceous as well. It was originally described from the shore sands of the Island of Cuba and is abundantly found in the California Miocene[77] and in the so-called "Upper Series" of the Trinidad Tertiary.[78] It is a common form in the Lobitos Formation (Middle Eocene), of Northwestern Peru,[79] but is very rare there in the Heath Formation (Upper Oligocene). The latter statement refers, however, to the form described as *Bulimina bicona* Berry, the inclusion of which into the synonymy of D'Orbigny's species may not be considered as positively certain. Speaking of the geological distribution of these species, it is necessary to take into consideration the fact that it may be present in localities from which is mentioned only either *Bulimina ovata* D'Orb. or *Bulimina pupoides* D'Orb., or both. Particularly it refers to *Bulimina pupoides* D'Orb., many figures of which in different papers may be more correctly considered as representing *Bulimina affinis* D'Orb.

C. M. I. F. No. 7017.

Family BULIMINIDAE—UNIGERININAE

SIPHOGENERINA Schlumberger

Siphogenerina transversa Cushman

Plate XL, figs. 30-31

1918. *Siphogenerina raphanus* var. *transversus* Cushman, The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 64, pl. 22, fig. 8.

1926. *Siphogenerina raphanus* var. *transversus* Cushman, Foraminifera of the Genera Siphogenerina and Pavonina: U. S. Nat. Mus. Proc. 67, art. 25, p. 6, pl. 1, fig. 6 (reproduction of the original figure).

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[76] l. c.

[77] Bagg, R. M., Jr., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 19, pl. II, fig. 1, 1905.

[78] Nuttall, l. c.

[79] Berry, E. W., The Foraminifera of the Restin Shale of Northwest Peru: Ecl. Geol. Helvetiae, XXI, 1928, p. 131; Berry, E. W., The Smaller Foraminifera of the Middle Lobitos Shale of N. W. Peru: Ibidem, p. 391.

1928. *Siphogenerina raphanus* var. *transversus* Nuttall, Tertiary Foraminifera from the Naparima Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 94, pl. VI, fig. 14.

1931. *Siphogenerina transversa* Cushman & Parker, Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California: Contr. Cushman Lab., VII, p. 10, pl. 2, figs. 5, 6.

1931. *Siphogenerina transversa* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal., V, p. 112, pl. 12, fig. 13.

Small, rather stout, subcylindrical form slightly tapering toward the lower end. Upper end rounded, smooth with small circular central aperture. Neck absent, or, perhaps was not preserved. Great portion of the test uniserial. The earlier chambers cannot be well distinguished. Sutures prominent between the eight longitudinal ribs. Length of the only complete specimen is about 0.6 mm., thickness, at the upper end, about 0.3 mm. Dimensions of a fragment show that this form could be a little larger than the one described.

The Colombian form is, relatively, a little shorter than the typical form from the Panama Canal Zone and lacks the short neck of the latter. The difference in dimensions is, however, very small, and the neck could have been destroyed secondarily. The form from the Miocene of the San Joaquin Valley is more conical and that from the Ventura County larger and relatively longer than the typical form.

At the Panama Canal Zone, the species was described from the dark clay in the lower part of the Culebra Formation (Oligocene) where it is frequent. Cushman mentioned it also from Brasso, Trinidad (British West Indies)[80] which, according to Liddle[81] is of the Middle Miocene age. From the so-called Upper Series of the Trinidad Tertiary it was mentioned also by Nuttall.[82] In the Miocene of Venezuela it was indicated by Cushman.[83] In California it was found in the Miocene, where it occurs "in enormous numbers" in the Lower Temblor Formation, but is much less common in the Upper Temblor. The genus Siphogenerina, according to Cushman, "was exceptionally well developed in the Miocene of our own Pacific coast as well as in Panama, Trinidad, Florida, and Maryland."[84]

C. M. I. F. No. 7018-7019.

[80] U. S. Nat. Mus. Proc., 76, l. c.

[81] Liddle, R. A., The Geology of Venezuela and Trinidad, p. 467, Fort Worth, Texas, 1928.

[82] Nuttall, l. c.

[83] Journ. Pal. V, p. 112.

[84] Cushman, J. A., Siphogenerina plummeri a Species from the Upper Cretaceous of Texas: Contr. Cushman Lab. II, p. 15, 1926.

Family ROTALIIDAE—DISCORBISINAE

DISCORBIS Lamarck

Plate XL, fig. 33

Discorbis floridensis Cushman

Plate XL, fig. 32

1930. *Discorbis bertheloti* D'Orbigny var. *floridensis* Cushman & Jarvis, Miocene Foraminifera from Buff Bay, Jamaica: Journ. Pal. IV, p. 364, pl. 33, figs. 13a-c.
1931.[85] *Discorbis bertheloti* var. *floridensis* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 17, pl. 3, figs. 3-5.

Test broad, plano-convex, compressed. Periphery keeled. Chambers, five in the final whorl. These increase rapidly in size and the last one extends to not less than one-half of the periphery. The structure of the ventral side is unknown. Sutures distinct, depressed, slightly limbate. Wall smooth, very finely and evenly perforated. Diameter (in two directions) 0.7 mm. and 0.8 mm.; thickness a little over 0.2 mm.

The only specimen present, although incomplete and distorted, looks so closely related to Cushman's species that its identification as this species appears to be well justified. The form was described by Cushman as a new variety of *Discorbis bertheloti* D'Orb., but it is distinguished from the latter sufficiently to be considered independent.

C. M. I. F. No. 7020.

Discorbis atratiensis sp. n.

Plate XL, figs. 33-34

Test broad, plano-convex, with chambers slightly swollen on the dorsal side. Sutures depressed, and generally indistinct, which, when one considers the opaque wall, makes detailed description of the species rather difficult. Number of chambers in the final whorl, apparently, five. Wall smooth, very finely and evenly perforated on the dorsal side, but apparently without perforations on the ventral side. Diameters over 0.5 and 0.4 mm.; thickness 0.2 mm.

This species is well distinguished from *Discorbis floridensis* Cushman, to which it is very similar in its general form, by the smaller relative size of the last chamber, very little but distinctly swollen chambers on the dorsal side of the test, thin sutures, lack of keel and finer perforation of the wall.

C. M. I. F. No. 7021.

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[85] This is the official year of publication. Description here given was already mentioned in Cushman and Jarvis' paper published in the Journal of Paleontology a year before.

GYROIDINA D'Orbigny

Gyroidina soldanii D'Orbigny

Plate XL, figs. 35-37

1926. *Gyroidina soldanii* D'Orbigny, Tableaux Méthodique de la classe de Céphalopodes: Ann. Sc. Nat., VII, p. 278, No. 5, Modèles de Céphalopodes, No. 36.
1931. *Gyroidina soldanii* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 38, pl. 8, figs. 3-8, (Synonymy).
1931. *Gyroidina soldanii* Cushman & Parker, Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California: Contr. Cushman Lab., VII, p. 11, pl. 2, figs. 9a-b.
1931. *Gyroidina soldanii* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal., V, p. 114, pl. 13, figs. 2a-c.

Test trochoid, relatively high, plano-convex, with dorsal side almost flat or very slightly convex in the middle. Convexity appears greater than it is on account of circular shallow channel on this side, typical for the genus. Ventral side convex with a narrow umbilicus. Periphery almost flat. Peripherial edge only slightly rounded or subacute. Aperture an elongated slit at the inner margin of the chamber. Wall finely perforate, opaque. Sutures inconspicuous and chambers indistinct. Diameter of the only specimen about 0.5 mm.; the height 0.4 mm.

Gyroidina soldanii D'Orb. a very common form in recent seas is quoted from many Tertiary localities, going, perhaps down into the Cretaceous. Its separation from the other species of the same genus is, however, not always easy and even the volume of its variations is considered different in different cases. In describing this species from the Temblor formation Cushman and Parker pointed out that it "is subject to considerable variation in the same sample, or in any considerable suite of fossil or recent specimens from a single locality." Referring to the species from the Los Sauces Creek, Cushman and Laiming tell that it "does not vary greatly." When describing the forms from the Atlantic Ocean, Cushman did not include in the synonymy most of the fossil records "as many of them do not belong to this species." The form from Colombia is apparently closely related to species recently described from the Miocene of California, but somewhat different from the recent forms from the Atlantic Ocean which have more rounded periphery, more convex dorsal side than the fossil forms, and could hardly be distinguished, at least on the basis of figures, from the closely related Atlantic species of *Gyroidina orbicularis* D'Orb. Comparison of figures 1b and 2b on plate 8 of Cushman's Atlantic monograph, representing *Gyroidina orbicularis* D'Orb., with fig. 4c referring to *Gyroidina soldanii* D'Orb., shows that the former species could be distinguished from *Gyroidina soldanii* D'Orb. perhaps only by its smaller size and the left-handed spiral. The importance of the latter character is, however, still rather indefinite in Foraminifera in general and is particularly so in relation to the genus under consideration in which both right and left forms are described indiscriminately.

It is hardly possible to give a complete and correct list of geological localities for this species. By referring only to recent papers it is possible to mention that this species was found abundantly in the Upper Eocene of Ecuador,[86] in the Miocene of Venezuela and Trinidad, in the Miocene of the Coastal Plain of the United States,[87] and in the Miocene of California.[88] *Rotalia* cf. *soldanii* D'Orb. was mentioned by Berry from the Saman Shales of Peru.[89] It is found in seventeen localities of Egypt and the Peninsula of Sinai, and in some of them it is very frequent.[90]

C. M. I. F. No. 7022.

Gyroidina sp.

Plate XL, figs. 38-40

This species is distinguished from *Gyroidina soldanii* D'Orb., by its smaller size, rounded periphery and peripherical edge, and by its more convex dorsal side. Aperture an elongate slit at the inner margin of the chamber. Ventral side convex with a narrow umbilicus. Sutures indistinct, and number of chambers unknown. Wall smooth, opaque, finely perforate. Diameter about 0.4 mm.; height about 0.3 mm.

Apparently this form is very closely related to *Gyroidina soldanii* D'Orb. var. *rotundimargo* R. E. & K. C. Stewart,[91] from the Lower Pico (Lower Pliocene). Many peculiar features of the Californian form, chiefly referring to the character of sutures, could not be checked

[86] Galloway, J. J., and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal., XV, No. 55, p. 27, pl. 4, fig. 4, 1929.

[87] Cushman, J. A., A Late Tertiary Fauna of Venezuela and other Related Regions: Contr. Cushman Lab., V, p. 98, pl. 14, figs. 7a, b, 1929.

[88] Cushman and Parker, Cushman and Laiming, l. c.

[89] Berry, E. W., The Smaller Foraminifera of the Middle Lobitos Shale of Northwestern Peru: Ecl. Geol. Helvetiae, XXI, p. 392, Basel 1928.

[90] Macfadyen, W. A., Op. cit., p. 103.

[91] Stewart, R. E. and K. C., Post-Miocene Foraminifera from the Ventura Quadrangle, Ventura County, California: Journ. Pal. IV, p. 68, pl. 9, figs. 3a-c.

on the Colombian specimen. In addition, the figure of the Californian species shows a left-handed form while this one under consideration is normal right. Cushman, while describing the recent *Gyroidina soldanii* D'Orb. from the West Coast of America,[92] mentioned a variety of this species "with more rounded peripheral angle and less distinct chambers," which according to the Stewarts belongs to their variety. Probably, the same refers to the form described by Cushman and the Stewarts from the Pliocene of Humboldt County, California.[93] A young form of *Gyroidina soldanii* D'Orb., described by Cushman from South America,[94] is, probably, closely related to this Colombian form.

C. M. I. F. No. 7023.

Family ROTALIIDAE—ROTALIINAE

EPONIDES Montfort

Eponides antillarum D'Orbigny

Plate XLI, figs. 1-3

1840. *Rotalina antillarum* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba por D. Ramon de la Sagra, p. 89, lam. V, figs. 4-6.

1930. *Eponides antillarum* Cushman & Jarvis, Miocene Foraminifera from Buff Bay, Jamaica: Journ. Pal., IV, p. 364, pl. 33, figs. 14a-c, pl. 34, fig. 2.

1931. *Eponides antillarum* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 42, pl. 9, figs. 2a-c. (Synonymy).

Test trochoid, biconvex, with the dorsal side usually more convex than the ventral one. Periphery subacute. Chambers numerous, all visible from the dorsal side, only those of the last formed whorl, seven or eight in number, from the ventral side. Sutures very oblique on the dorsal side, rather indistinct or sometimes not visible at all. On the ventral side they are almost radiate and often limbate near the umbilicus, which is closed. Wall thick, smooth, porcellaneous, opaque. The species undergoes rather wide variations in its general shape, varying especially in its height. Forms having a thick wall and indistinct sutures could be brought into association with this species only by comparison with more transparent specimens and by tracing the alteration of this character. Such a form, for example, is figured by Cushman from Jamaica.[95]

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[92] Cushman, J. A., Recent Foraminifera from off the West Coast of America: Bull. Scripps Inst., Techn. Ser. I, No. 10, p. 162, 1927.

[93] Cushman, J. A. and Stewart, R. E. and K. C., Tertiary Foraminifera from Humboldt County, California: Trans. San Diego Soc. Nat. Hist., VI, No. 2, p. 72, pl. 6, figs. 1a-c, 1930.

[94] Cushman, J. A., A Late Tertiary Fauna of Venezuela and Other Related Regions: Contr. Cushman Lab. V, p. 98, pl. 14, figs. 6a-b, 1929.

DIMENSIONS IN MM.

Diameter	Height	
0.9	0.4	
0.8	0.5	
0.7	0.4	(figured specimen)
0.4	0.2	

This species is very common in the Colombian fauna. Its geographical and geological distribution appears to be rather limited chiefly because this species was usually identified as *Eponides schreibersii* D'Orb.,[96] and distinction of the two species is not established yet with desirable exactness. Probably the form described by Bagg,[97] under the name of *Pulvinula schreiberii* D'Orb. from the Eocene of Woodstock, Virginia, and the Miocene of the James River, Virginia, belongs to the species under consideration.

C. M. I. F. No. 7029-7030.

Eponides praecinctus Karrer

Plate XLI, figs. 4-6

1868. *Rotalia praecincta* Karrer, Die miocenenen Foraminiferen-fauna von Kostej im Banat: Sitz. Ber. d. K. Akad. Wiss., Bd. LXXXVIII, S. 189, Taf. V, Fig. 7, Wien.

1915. *Truncatulina praecincta* Cushman, A. Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 5, p. 39, figs. 42a-c, pl. 26, figs. 2a-c, (Synonymy).

1923. *Rotalia soldanii* Hanna, Some Eocene Foraminifera near Vacaville, California: Univ. California Publ., XIV, No. 9, p. 325, pl. 59, fig. 3a-c.

1930. *Rotalia soldanii* Krenzberg, Eine tertiäre Foraminiferen-fauna von Neuseeland: N. J. Abt. B., Beil. Bd. LXIV, S. 288, Taf. XXI, fig. 14a-c.

Test very variable in its general shape. Some specimens are almost equally biconvex with the ventral side only a little more convex than the dorsal one. In other specimens the dorsal side is flat or almost flat and the ventral one is conical, more or less high, with an acute apex or quite blunt. The shape of the latter depends on the size of the umbilicus filled up with shell substance. Periphery acute, with a keel differently developed in different forms. The innermost whorls are covered on the dorsal side with a layer of shell substance and only about two whorls can be distinguished here. Chambers distinct, all of more or less uniform shape, not inflated, increasing in size only slightly and gradually. About ten chambers belong to the last-formed whorl. Sutures distinct, slightly limbate, neither depressed, nor protruding, confluent with the keel and spiral suture. They are strongly oblique on the dorsal side, rather radial and only slightly curved on the ventral side. Wall very finely perforate. Aperture in the form of a short slit at the base of the chambers.

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[95] Cushman, J. A., Foraminifera from the North Coast of Jamaica: U. S. Nat. Mus. Proc. 59, No. 2360, pl. 13, figs. 7, 8, 1921.

[96] D'Orbigny, A., Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche) p. 154, pl. VIII, figs. 4-6, Paris, 1846. (Reproduction in Galloway's Plates of Foraminifera, V, p. 84).

[97] Bagg, R. M., The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope: Bull. Am. Pal., II, No. 10. p. 37, pl. 3, figs. 2a-c. 1898.

DIMENSIONS IN MM.

Diameter	Thickness	Relation of heights of dorsal and ventral sides
0.7	0.4	
0.5	0.3	(figured specimen)
1.2	0.6	10:13

Some varieties of the Colombian form can hardly be distinguished from the Miocene *Rotalia praecincta* Karrer. From the Lower Miocene (so-called Ihungia layers) this species was described also from New Zealand, and from the Eocene of the Western Coast of North America. In recent seas this form has been found in many localities of the Pacific Ocean, apparently preferring warm and comparatively shallow waters.[98]

C. M. I. F. No. 7031-7032.

Eponides limbatus sp. n.

Plate XLI, figs. 7-9

Test trochoid, almost equally biconvex, with acute peripheral margin. Five or six narrow strongly curved chambers are distinguishable in the last-formed whorl. Sutures strongly limbate on both sides and raised on the dorsal one. Umbilicus filled with the shell material, the filling closely confluent with the round surface of the ventral side. Chambers and sutures rather indistinct here. Aperture poorly preserved, apparently located near the peripheral margin. Wall rather coarsely perforate, in some chambers pores distributed in rows along sutures. Diameters 0.35 and 0.4 mm.; height about 0.2 mm.

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[98] Cushman, J. A., Foraminifera of the Philippine and Adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 319, 1921.

The dorsal side of this species is very similar to that of *Rotalina concamerata* Will.,[99] whereas the English form is almost flat on the ventral side and somewhat umbilicate.

C. M. I. F. No. 7033.

Eponides sp.

Plate XLI, figs. 10-12

Test biconvex with almost equally high dorsal and ventral sides. Dorsal side regularly roundly convex. Ventral side more conical. Chambers numerous, 12-15 to the last formed whorl. They could not be distinguished on the dorsal side on account of the very thick wall and the same refers to the sutures which are here apparently only slightly bent. Sutures and chambers are better seen on the ventral side where the sutures run almost radially. The largest part of the ventral side is taken up by the massive filling of the umbilicus, which is closely connected with the wall of the test. Diameters of one specimen 0.43 and 0.4; its height 0.24 mm.

This form is closely related to *Eponides praecinctus* Karrer, from which it is distinguished chiefly by the massive plug in the umbilicus. The dorsal side is also a little different being more regularly round, but this roundness may be produced by the thickening of the wall of the test.

C. M. I. F. No. 7034-7035.

Family ROTALIIDAE—SIPHONININAE

SIPHONINA Reuss

Siphonina antioguiensis sp. n.

Plate XLI, figs. 13-15; pl. XLII, figs. 28-29

Test nearly circular, almost equally biconvex, with the ventral side only a little more convex than the dorsal one. Periphery subacute or even slightly keeled. Chambers are indistinct on the dorsal side. Four may be differentiated in the last-formed whorl on the ventral side separated here by depressed limbate sutures. Umbilicus filled with the shell material. Aperture elliptical with a low, but distinct, neck and rather thin lip. Wall smooth, perforated rather coarsely. Pores are more abundant on the ventral side than on the dorsal one and are distributed more or less concentrically in the central part of the former. Near the periphery the pores apparently reach the surface obliquely and have, therefore, somewhat elliptical or comma-like shape, which makes the keel fimbriate, although it does not affect its peripherial margin.

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[99] Williamson, W. C., On the Recent Foraminifera of Great Britain: The Ray Society, p. 52, pl. IV, figs. 101-105, London, 1858. Reproduced in Galloway's Plates of Foraminifera, I, p. 193.

DIMENSIONS IN MM.

	Diameter	Thickness	Length of aperture
About	0.6	0.3	0.08
	0.54	0.27	Inner cast

This species is very closely related to *Siphonina advena* Cushman, var. *eocenica* Cush. & Appl. as it is figured in Cushman's monograph[100] on this genus. There are, however, between these figures and those given primarily for this variety[101] some differences which do not permit one to consider the South American form identical with the North American one without direct comparison of both of them.

C. M. I. F. No. 7036, 7071.

Siphonina chocoiensis sp. n.

Plate XLI, figs. 16-18

Test biconvex, somewhat lobate, with the ventral side nearly twice as convex as the dorsal one. Periphery subacute. About five chambers on the dorsal side, separated by rather indistinct depressed septa. The periphery slightly fringed. Umbilicus filled. Aperture elliptical, without any neck but with a well expressed lip, located on the lower side of the marginal border. Wall smooth, rather coarsely perforated, although less so than in *Siphonina antioguiensis* m. Pores are round over the whole surface of the ventral side, rather scarce in the middle part of the dorsal side, but also very abundant here in the peripheral belt. On the marginal border they are a little stretched.

Diameter in two directions 0.43 and 0.38 mm., thickness 0.22 mm. This form is clearly distinguished from *Siphonina antioguiensis* m. by its general shape, lack of the apertural neck, and different perforation. *Siphonina chocoiensis* m. reminds one of some Eocene forms, since it is without the neck, and slightly lobate, as is *Siphonina prima* Plummer,[102] but it is distinguished from the latter by its general shape.

C. M. I. F. No. 7037.

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[100] Cushman, J. A., Foraminifera of the genus Siphonina and Related Genera: Proc. U. S. Nat. Mus. 72, art. 20, p. 6, pl. 4, figs. 3a-c, 1927.

[101] Cushman, J. A., and Applin, E. R., Texas Jackson Foraminifera: Bull. Am. Asso. Pet. Geol., X, p. 182, pl. 10, figs. 18-19, 1926.

[102] Plummer, H. J., Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 148, pl. XII, figs. 4a-c. 1926.

Family AMPHISTEGINIDAE

AMPHISTEGINA D'Orbigny

Amphistegina lessoni D'Orbigny

Plate XL, figs. 43-44

1826. *Amphistegina lessoni* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. d. Sc. Nat., VII, p. 304, pl. 17, figs. 1-4, Paris (Reproduced in Galloway's Plates of Foraminifera, I, p. 101).

1884. *Amphistegina lessoni* Brady, Report of the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, IX, p. 740, pl. CXI, figs. 1-4 (Figs. 5-7 excl.) Edinburgh.[103]

1898. *Amphistegina lessoni* Bagg, The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope: Bull. Am. Pal., II, No. 10, p. 43, pl. I, figs. 6a-c.

1919. *Amphistegina lessoni* Cushman, Fossil Foraminifera from the West Indies: Carn. Inst. Washington Publ. 291, p. 50, pl. 7, fig. 7.

1924. *Amphistegina lessoni* Van der Vlerk, Foraminiferen uit Het Tertiair van Java: Wetenschappelijke Mededeelingen, No. 1, p. 23, pl. V, fig. 20, Weltevreden.

1928. *Nummulites carmenensis* Anderson, Notes on Lower Tertiary Deposits of Colombia and their Molluscan and Foraminiferal Fauna: Proc. Cal. Ac. Sc., IV Ser., XVII, p. 26, pl. 1, figs. 23, 24, San Francisco.

1929. *Amphistegina radiata* (ad partim) Yabe & Hanzawa, Tertiary foraminiferous Rocks of the Philippines: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XI, No. 3, p. 179, pl. XVIII, fig. 6.

1930. *Amphistegina radiata* Yabe & Hanzawa, Tertiary foraminiferous Rocks of Taiwan (Formosa): Sc. Rep. Tôhoku Imp. Univ., XIV, No. 1, p. 39, pl. I, figs. 6, 8; II, fig. 5; III, fig. 6; V, figs. 6-7; VI, figs. 8, 12; VII, figs. 1, 2, 8, 9; VIII, figs. 1, 4, 5; IX, figs. 12, 13; XII, fig. 5; XIV, figs. 4, 5.

1930. *Amphistegina lessoni* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 57, pl. 11, figs. 5a-c.

1931. *Amphistegina radiata* Hanzawa, Notes on Tertiary Foraminiferous Rocks from the Kwantô Mountainland, Japan: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), p. 156, pl. XXIV, fig. 7; pl. XXVI, figs. 6-8.

1932. *Amphistegina lessoni* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal., VI, p. 27, pl. 6, fig. 12.

1933. *Amphistegina lessoni* Cushman & Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 32, pl. 11, figs. 6a-c.

Test biconvex with many oblique chambers, the number of which, in the last formed whorl, may be more than 25. Sutures oblique and sharply angled near the periphery. The latter is bluntly rounded or subacute in some specimens. The general shape is extremely variable, particularly with respect to the thickness, which may attain a half of the diameter or be less. The middle part of the test, the umbo, may be more or less prominent or may be confluent with the corresponding side of the test. Wall smooth.

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[103] According to Thalmann (Ecl. Geol. Helvetiae, XXV, p. 311) forms described by Brady should be named *Amphistegina radiata* Ficht. & Moll. Cushman, however, keeps Brady's identification for the forms described by the latter.

DIMENSIONS IN MM.

	Diameter	Thickness	Number of chambers
Fig. 43	1.6	0.8	over 25
	1.1	0.6	over 20
Fig. 44	1.8	0.6	over 25
	2.4 (greatest d.)		about 27 (median section)

Amphistegina lessoni D'Orb. is the most common foraminifer in the fauna under consideration. Although variable in its general shape, it does not go beyond certain limits given in the above description in its variations. Neither the thick forms figured by Brady in figs. 5, 6, of the Challenger work, nor unsymmetrical varieties figured by him under No. 7, were found in the Colombian material. This shows that three groups of forms which Brady distinguished in the *Amphistegina lessoni* D'Orb. are more than individual variations of the same species. It is, therefore, hardly advisable to consider that all these varieties belong to the same species of *Amphistegina lessoni* D'Orb. as did Brady, and as has been done by most paleontologists who have dealt with this species. D'Orbigny himself was partly responsible for such a wide interpretation of his species because his model of *Amphistegina lessoni* D'Orb. does not correspond to his figures. Only the varieties described by Brady as "Compressed lenticular form" should be considered as belonging to *Amphistegina lessoni* D'Orb., *sensu stricto*. Figures 1-4 of Brady's monograph correspond well to those of D'Orbigny and at the same time show some amount of variation which si observed, for example, in the fauna under consideration. Brady's interpretation of the species was accepted by Cushman for the form of the North Pacific, although the variety figured by him has only a few chambers,[104] and also for the form from the Phillippines.[105] In his last paper on the Atlantic Foraminifera Cushman abandoned any attempt to complete references to this species, "As there are several species and varieties in the present oceans especially in the Indo-Pacific."[106] These words refer just as well to the fossil forms. The form figured in the last quoted paper of Cushman is different from the typical species, as it is interpreted in the present paper. *Amphistegina lessoni* D'Orb. was identified by Church from Colombia, where it was found within the lowest horizon, M-N, of the Tubera Group, Lower Miocene, according to Anderson.[107] Since no figures are given and the description does not contain any details about the characters of the species, it is not possible to be certain as to its systematic position. *Nummulites carmenensis* And., from the Middle Eocene of Colombia, may be an inner cast of *Amphistegina lessoni* D'Orb. At least, among many specimens of the latter species from Colombia, there are found inner casts which correspond exactly to the figures given by Anderson. The probability for such a guess is indicated to a certain extent, by the following remark of Anderson: "There is considerable difficulty in freeing the specimens from the matrix rock, and there is some indication that when fully mature the test does not present the radially ribbed appearance, shown in the photographs, but is coarsely nodose."[108] As the "radially ribbed surface" is the most important character of this species, its validity appears to the writer rather doubtful and in any case should be further checked.

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[104] Cushman, J. A., Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 35, pl. 19, fig. 2, 1914.

[105] Cushman, J. A., Foraminifera of the Philippine and adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 370, 1921.

The form described from the Panama Canal Zone[109] was not figured, but the description is complete enough to make one sure that it was *Amphistegina lessoni* D'Orb., *sens. str.* It was found here in the Culebra Formation and Emperador Limestone (Oligocene), also in the Gatun Formation (Miocene). On the Atlantic slope of North America this species was described from the Eocene of Woodstock, Virginia, and the Miocene of Darlington, South Carolina.[110] As is shown by the synonymy it is known in the Lower Oligocene of Mexico, in the Miocene of Jamaica, Florida, and several other localities of the Coastal Plain of the United States. The form described from the Lower Miocene of Java corresponds apparently very closely to the typical species. The Miocene form from Egypt is not figured but according to the description belongs to the typical variety.[111]

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[106] Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 79, pl. 16, figs. 1-3, 1931.

[107] Anderson, F. M., Marine Miocene and Related Deposits of North Colombia: Proc. Cal. Acad. Sc. IV Ser., XVIII, p. 179, 1929.

[108] l. c., p. 27.

[109] Cushman, J. A., The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 77, 1918.

[110] Bagg, R. M., Jr., l. c.

In the synonymy of this species is included also *Amphistegina radiata* Ficht. & M.,[112] described from different Miocene localities of Japan, because Japanese authors used this specific name very broadly, covering with it, also, the varieties corresponding to *Amphistegina lessoni* D'Orb.[113]

Amphistegina lessoni D'Orb. or, better to say, all the related species brought into this association being very common Tertiary forms are reported also from the Carboniferous and Triassic. The species is also abundantly found in recent seas, being typical particularly for shallow water sands of warm seas.

C. M. I. F. No. 7026-7028.

Amphistegina hauerina D'Orbigny

Plate XL, figs. 41-42

1846. *Amphistegina hauerina* D'Orbigny, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche), p. 207, pl. XII, figs. 3-5, Paris. (Reproduced in Galloway's Plates of Foraminifera, V, p. 92).

The test of this species is distinguished from that of *Amphistegina lessoni* D'Orb. only by its general form. It has a rather strongly protruding, although not large umbonal boss, from which towards the periphery the surface of the test is a little concave. The periphery is subacute and even a little keeled.

DIMENSIONS IN MM.

Diameter	Thickness	Number of chambers
1.2	0.6	about 25, figured specimen
1.0	0.4	over 20
0.8	0.3	over 20

This form, described originally from the Miocene of Austria, was later included in the synonymy of *Amphistegina lessoni* D'Orb. and lost in the literature. It was, however, mentioned as a variety of the latter species from the Miocene of Egypt by Macfadyen.[114] As the figures of D'Orbigny and also direct comparison with the Austrian specimen show, characters distinguishing the two species are well expressed and stable.

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[111] Macfadyen, W. A., Op. cit. p. 106.

[112] *Nautilus radiatus* Fichtel, L. V. & Moll, J. P. C. v., Testacea microscopica aliaque minuta et generibus *Argonauta* et *Nautilus* ad naturam delineata et descripta, p. 58, Tab. 8, figs. a-d, Wien 1803 (Second Edition). After Galloway's Plates of Foraminifera, I, p. 23.

[113] Sc. Rep. Tôhoku Univ. 2nd Ser (Geology), XI, No. 3, p. 179.

[114] Op. cit., p. 107.

This species is well represented in the fauna under consideration.

C. M. I. F. No. 7024-7025.

Family GLOBIGERINIDAE—GLOBIGERININAE

GLOBIGERINA D'Orbigny

Globigerina bulloides D'Orbigny

Plate XLI, figs. 19-20

1826. *Globigerina bulloides* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. Sc. Nat., VII, p. 277, No. 1, Modéles des Foraminifères No. 17, 76, Paris.

1914. *Globigerina bulloides* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 5, pl. 2, figs. 7-9, pl. 9, (Synonymy).

1918. *Globigerina bulloides* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 56, pl. XII, figs. 4-6.

1920. *Globigerina bulloides* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Paper 128-B, p. 69, pl. XI, fig. 6.

1922. *Globigerina bulloides* Cushman, The Foraminifera of the Byram Calcareous Marl at Byram, Mississippi: U. S. G. S. Prof. Paper 129-E, p. 95, pl. XIX, figs. 1-3.

1924. *Globigerina bulloides* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, pl. 2, figs. 1-4.

1927. *Globigerina bulloides* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 40, pl. 7, figs. 4a-c.

1928. *Globigerina bulloides* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 192, pl. 27, fig. 12.

1928. *Globigerina bulloides* Cushman, Foraminifères du Stampien du Bassin de Paris: Bull. Soc. Sc. de Seine-& Oise, Sér. II, Tome IX, p. 56, pl. III, figs. 5a-c, 6a-c. Versailles.

1929. *Globigerina bulloides* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, fig. 5.

1930. *Globigerina bulloides* Cole & Gillespie, Some Small Foraminifera from the Meson Formation of Mexico: Bull. Am. Pal. XV, No. 57b, p. 13, pl. 2, fig. 16.

1930. *Globigerina bulloides* Macfadyen, Miocene Foraminifera from the Clysmic Area of Egypt and Sinai: Geol. Surv. of Egypt, p. 94, pl. IV, figs. 2a, b, Cairo.

1930. *Globigerina bulloides* Cushman & Barksdale, Eocene Foraminifera from Martinez, California: Contr. Dept. Geology, Stanford University, I, p. 67, pl. 12, figs. 6a-b.

1931. *Globigerina bulloides* Hanzawa, Notes on some Eocene Foraminifera found in Taiwan (Formosa), with Remarks on the Age of the Hori Slate Formation and crystalline Schists: Tôhoku Imp. University Sc. Rep., 2 Ser. (Geology), XII, No. 2A, p. 177, pl. XXIX, figs. 10-12.

1931. *Globigerina bulloides* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 117, pl. 14, figs. 4a-c.

1932. *Globigerina bulloides* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal. VI, p. 29, pl. 6, figs. 13-15.

Test subglobose, trochoid, composed of a few inflated subspherical chambers all of which are visible from the dorsal side, but only three or four of the last formed whorl may be seen from the ventral side. Sutures deep. Wall coarsely perforate. Average dimensions about 0.4 mm. in diameter.

Brady refers to this species as a cosmopolitan one which used to be found in all seas at almost every latitude and "in surface-gatherings wherever Foraminifera have been collected."[115] In later time, however, this statement could not be considered commonly accepted. In Cushman's opinion, for example, "*G. bulloides,* if present, is a very rare species in the western Atlantic"[116] and "it is not one characteristic species of the eastern Pacific."[117] Fossil *Globigerina bulloides* D'Orb. is also considered a very widely distributed form, but perhaps more critical identification of the species will bring the same results as revision of recent forms, that is, make its distribution much narrower than that now accepted. Bagg mentioned,[118] for example, that according to Terquem this species was already present in the Devonian. In Terquem's paper,[119] to which reference has been made, there was described a *Globigerina* without any specific name, thus it can only be interpreted as an indication of the appearance in the Devonian of the genus, not the presence of this particular species. It is, however, abundantly found in the Cretaceous and continues through the whole Tertiary towards Recent time.

As follows from the above given records, this species was described recently in the Western Hemisphere in California from the Pleistocene,[120] the Miocene,[121] in which sediments it was not before described,[122] and from the Eocene. In Mexico this species was found in the Upper Cretaceous[123] and in the Lower[124] and Middle[125] Oligocene. In Ecuador it was found in the Upper Eocene.[126] Along the Coastal Plain of the United States it was found in the Oligocene of Mississippi[127] and in the Miocene of Virginia and Florida.[128] In the Panama Canal Zone it was found in different localities of the Culebra Formation, as well as of the Gatun Formation.[129]

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[115] Brady, H. B., Op. cit., p. 595.

[116] Cushman, J. A., Recent Foraminifera from off the West Coast of America, Scripps Inst. Bull. Techn. Ser. I, No. 10, p. 171, 1927.

[117] U. S. Nat. Mus. Bull. 104, part 5, p. 7.

[118] Bagg, R. M., Jr., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 78, 1912.

[119] Terquem, O., Observations sur quelques fossiles des époques primaires: Bull. Soc. Géol. France, Sér. 3, VIII, p. 418, pl. XI, figs. 10a-e, Paris, 1880.

C. M. I. F. No. 7038-7039.

Globigerina tricamerata sp. n.

Plate XLI, fig. 21

1884. *Globigerina bulloides* var. *triloba* Brady, Report on the Foraminifera dredged by H. M. S. Challenger, during the years 1873-1876: Challenger Report, Zoology, IX, p. 595, pl. LXXXI, figs. 2-3, Edinburgh.

1931. *Globigerina bulloides* var. *tribloba* Hanzawa, Notes on some Eocene Foraminifera found in Taiwan (Formosa), with Remarks on the Age of the Hori Slate Formation and crystalline Schists: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XII, No. 2A, p. 182, pl. XXIX, fig. 12 (Synonymy).

1932. *Sphaeroidina* (?) *peruviana* Berry, The Foraminifera of the Heath Formation of Northwestern Peru, South America: Ecl. Geol. Helvetiae, XXV, No. 1, p. 29, pl. II, fig. 4.

Test subovoidal composed of three large final chambers, closely connected together, the last one of which almost equals in its size two other ones, or may be even larger than those. Sutures depressed, but not so deeply as usually in *Globigerinae*. Aperture not well known, apparently single and small on the last chamber, and opens into the umbilicus. Wall perforated rather coarsely. The length 0.32 mm.

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[120] Journ. Pal. I, p. 40, pl. 7, figs. 4a-c.

[121] Journ. Pal. V, p. 117, pl. 14, figs. 4a-c.

[122] Bagg, R. M., Jr., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 77, pl. XXIII, figs. 2a-z, 3-8, 1912. Bagg, R. M., Jr., Miocene Foraminifera from the Monterey Shale of California with a few species from the Tejon Formation: U. S. G. S. Bull. 75, p. 41, pl. VII, fig. 7, 1905.

[123] Journ. Pal. II, p. 192, pl. 27, fig. 12.

[124] Journ. Pal. VI, p. 29, pl. 6, figs. 13-15.

[125] Cole and Gillespie, l. c.

[126] Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, fig. 5.

[127] U. S. G. S. Prof. Pap. 129-E, p. 95, pl. XIX, figs. 1-3.

[128] U. S. G. S. Bull. 676, p. 56, pl. XII, figs. 4-6; U. S. G. S. Prof. Pap. 128-B, p. 69, pl. XI, fig. 6.

[129] Cushman, J. A., The Smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 64, 1918.

A great confusion exists in the literature with reference to *Globigerina triloba* Reuss.[130] As may be seen on Reuss' figures, he described a form composed chiefly of three large chambers of the last formed whorl, but displayed also the small chambers of the preceding convolutions, and accessory apertures on the dorsal side of the test. Brady describing this form, as a variety of *Globigerina bulloides* D'Orb., gave figures of several rather different forms. His following description of forms "with final convolutions consisting of three relatively very large segments which sometimes form the entire visible shell," refers to figures 2 and 3 of Plate LXXXI, quoted above, and representing "bottom species." Varieties figured on Plate LXXIX are entirely different. There are, further, no supplementary apertures represented on Brady's figures, and he did not mention them in his description. Macfadyen was, probably, quite right in suggesting that supplemental apertures were probably not present in the specimens studied by Brady.[131] In the Egyptian specimens closely related to those of Austria, supplemental apertures were found often more numerous than stated by Reuss. Apparently Brady had in his hands forms similar to Reuss' species, but distinct enough to be considered specifically different. To the same conclusion apparently came Macfadyen. At least he did not include Challenger's forms in the synonymy of *Globigerina triloba* Reuss.

As a matter of fact, in most cases it is impossible to decide to which form the mention of *Globigerina triloba* Reuss refers, unless the description is accompanied by good figures. It may be the species under consideration, or *Globigerina bulloides* D'Orb., or *Globigerina trilocularis* m., next described. All three forms are closely related to each other, sometimes found together, and when not, may be considered vicarious from the stratigraphical point of view. The following data on the distribution of *Globigerina triloba* Reuss should be accepted, while keeping in mind these considerations. In the north Pacific Ocean, *Globigerina triloba* Reuss is found nearly everywhere with *Globigerina bulloides* D'Orb., but seems to be much less common.[132]

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[130] Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiär-beckens: Denkschr. K. Akad. Wiss., Math. Nat. Wiss. Klasse, I, s. 374, Taf. XLVII, fig. 11a-e, Wien, 1850. Reproduced in Galloway's Plates of Foraminifera, V, p. 126.

[131] Macfadyen, W. A., Op. cit., p. 95.

[132] Cushman, J. A., A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 6, 1914.

It seems to be rare in the seas in the area of the Philippine Islands.[133] The species was found occasionally in the Panama Canal Zone in three localities of the Gatun Formation.[134] It was described from the Vicksburg Group of Mississippi.[135] In the Atlantic Ocean, according to Cushman, "Variety *triloba* Reuss is very nearly wanting.[136] Possibly this species was described by Hanzawa from the Japanese Eocene as a variety of *Globigerina bulloides* D'Orb. Into the above synonymy is included also *Sphaeroidina* (?) *peruviana* Berry from the Upper Oligocene of Peru, South America, which may belong to the variety described by Brady as, indeed, was suggested by Berry himself. In the fauna under consideration this species is almost as common as *Globigerina bulloides* D'Orb.

C. M. I. F. No. 7040-7041.

Globigerina trilocularis D'Orbigny

Plate XLI, figs. 22-23

1826. *Globigerina trilocularis* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. Sc. Nat., VII, p. 277, No. 2.

1898. *Globigerina trilocularis* Fornasini, Le Sabbie Qialle Bolognesi e le Richerche di J. B. Beccari. Intonio ad Alcusir foraminiferi illustrati da O. G. Costa: Rendi Sess. R. Accad. Sc. Inst. Bologna, n. ser. II, p. 12, fig. 2,[137] fasc. 7, figs. 6, 7, 7a (Reproduced in Galloway's Plates of Foraminifera IV, p. 66).

1899. *Globigerina triloba* Egger, Foraminiferen und Ostracoden aus den Kreidemergeln der Oberbayerischen Alpen: Abh. Math. Phys. Kl. d. K. Bayer. Akad. Wiss. XXI, p. 171, Taf. XXI, fig. 8, München. Reproduced in Galloway's Plates of Foraminifera, VII, p. 154.

1920. *Globigerina bulloides* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Pap. 128-B, p. 69, pl. XI, fig. 6.

1926. *Globigerina triloculinoides* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 134, pl. VIII, figs. 10a-b.

1928. *Globigerina pseudotriloba* White, Some Index Foraminifera of the Tampico. Embayment Area of Mexico: Journ. Pal. II, p. 194, pl. 27, figs. 17a-b.

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[133] Cushman, J. A., Foraminifera of the Philippine and Adjacent Seas: U. S. Nat. Mus. Bull. 100, Vol. 4, p. 286, 1921.

[134] Cushman, J. A., The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 65, 1918.

[135] Cushman, J. A., The Foraminifera of the Vicksburg Group: U. S. G. S. Prof. Paper 133, p. 35, 1923; Cushman, J. A., The Byram Calcareous Marl of Mississippi and its Foraminifera: U. S. G. S. Prof. Pap. 129-E, p. 95, 1922.

[136] Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, 1924.

[137] Reproduction of the unpublished figure by D'Orbigny of *Globigerian triolocularis* D'Orb. from the Middle Miocene of Bordeau, France.

1928. *Globigerina triangularis* White, Ibidem, p. 195, pl. 28, figs. 1a-b.

1928. *Globigerina velascoensis* White, (non Cushman) Ibidem, p. 196, pl. 28, figs 2a-b.

1929. *Globigerina triloba* Cushman & Wickenden, Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc. 75, Art. 9, p. 13, pl. 6, figs. 1a-c.

1929. *Globigerina trilocularis* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta Ecuador: Bull. Am. Pal. XV, No. 55, p. 10, pl. 3, figs. 9a-b.

1931. *Globigerina triloculinoides* Galloway & Morrey, Late Cretaceous Foraminifera from Tabasco, Mexico: Journ. Pal. V, p. 348, pl. 39, figs. 11a-b.

Test more or less ovoidal, composed chiefly of three large chambers of the last-formed whorl, the last one of which is almost equal in its size to two preceding ones taken together. Sutures depressed but rather shallow and all three chambers together make a rather compact structure. Besides the three chambers, there can be seen several preceding chambers which are of much smaller size and separated from each other and from the three fundamental chambers by shallow sutures. They make a rather indistinct low convulution. Aperture apparently small, single, on the last chamber, opening into the umbilicus. Wall rather coarsely perforate. Length 0.32 mm.

This species is closely related to *Globigerina tricamerata* m. from which, as well as from *Globigerina triloba* Reuss,[138] it is distinguished only by the presence of former convolutions. The necessity of distinguishing this form from Reuss' species was shown by Plummer, in 1926, and a new specific name—*triloculinoides* was introduced by her. However, D'Orbigny had described, in 1826, without figures, *Globigerina trilocularis* D'Orb., which possesses characteristics required for the species under consideration, as it is now possible to see after the publication of D'Orbigny's figures by Fornasini. Simultaneously, the latter described this species also from the Pliocene. Three species described by White from the Mexican Upper Cretaceous correspond, in the writer's opinion, to D'Orbigny's species and are not sufficiently different from each other to be considered separately. The last of them does not correspond, apparently, to *Globigerina velascoensis* Cushman, as shows[139] a comparison with figures given by the latter author.

[138] Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiär-beckens: Denkschr. K. Akad. Wiss. Math. Nat. Wiss. Klasse, I, s. 374, Taf. XLVII, fig. 11a-3, Wien, 1850. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126).

[139] Cushman, J. A., Some new Foraminifera from the Velasco Shale of Mexico: Contr. Cushman Lab., I, p. 19, pl. 3, figs. 5a-c.

As has been stated in the above synonymy, this species, described at first from the Miocene of France, was found in the Cretaceous, Eocene, Pliocene, and also recently in the Pacific Ocean. In the fauna under consideration it is rare.

C. M. I. F. No. 7042-7043.

Globigerina dutertrei D'Orbigny

Plate XLI, figs. 24-25

1840. *Globigerina dutertrei* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la isla de Cuba por D. Ramon de la Sagra, 5, p. 95, lam. IV, figs. 19-21, Paris.

1850. *Globigerina concinna* Reuss, Neue Foraminiferen aus den Schichten des oesterreichischen Tertiärbeckens: Denkschr. d. K. Akad. Wiss. Math. Naturw, Klasse, I, p. 373, Taf. XLVII, fig. 8a, b. Wien. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126.)

1844. *Globigerina dutertrei* Brady, Report of the Foraminifera dredged by H. M. S. "Challenger" during the years of 1873-1876: Challenger Report, Zoology, IX, p. 601, pl. LXXXI, figs. 1a-c. Edinburgh.

1926. *Globigerina pseudo-bulloides* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. No. 2644, p. 133, pl. VIII, figs. 9a-c.

1927. *Globigerina concinna* Galloway & Wissler, Pleistocene Foraminifera from the Limita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 41, pl. 7, figs. 7a-c.

1929. *Globigerina conglomerata* Cushman & Wickenden, Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc. 75, Art. 9, p. 12, figs. 6a-c.

1929. *Globigerina pseudo-bulloides* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 10, pl. 3, 3, figs. 8a-c.

1931. *Globigerina pseudo-bulloides* Galloway & Morrey, Late Cretaceous Foraminifera from Tabasco, Mexico: Journ. Pal. V, p. 347, pl. 99, figs. 9a, b.

1932. *Globigerina concinna* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal. VI, p. 29, pl. 6, figs. 9-11.

Test rotaliform, almost circular, convex on both sides, with thin and rounded periphery. The last whorl consists of five chambers gradually increasing in size, somewhat inflated, especially the last one. Sutures depressed. The earlier whorls may be seen on the dorsal side, but they are only indistinctly differentiated here. Aperture single and in the umbilical area on the inner side of the last-formed chamber. Wall rather coarsely perforated.

DIMENSIONS IN MM.

Diameter	Thickness
0.27–0.35	0.21

This species had been described by D'Orbigny from Cuba, but was never revised. In Cushman's opinion it is a "rather doubtful species"[140] concerning the characters and relations of which it is impossible to say anything definite "until D'Orbigny type specimen can be studied."[141] The most important feature of the species is the almost circular shape of the last-formed whorl and its construction of five inflated chambers gradually increasing in size, making a rather thick test, and also the position and shape of the single aperture. The character of the last-formed whorl well distinguishes this species from *Globigerina conglomerata* Schwager, in the synonymy of which *Globigerina dutertrei* D'Orb. is included by Thalmann.[142] As follows from the above synonymy, *Globigerina concinna* Reuss and *Globigerina pseudo-bulloides* Plummer, have been referred to D'Orbigny's species. Comparison of figures of all these species in the different articles quoted above shows distinctly that, in any case, they are very closely related forms. Since a "General chaos exists in the literature regarding the characteristics of Globigerine forms of this type,"[143] identification of this species may be only tentative.

According to the quoted literature, *Globigerina dutertrei* D'Orb. was found fossil in the Eocene of Texas and Ecuador, the Lower Oligocene of Mexico, the Miocene of Austria, and the Pleistocene of California. It is also a recent form of the Atlantic and possibly the Pacific Oceans, particularly if it would be correct to include in the synonymy of this species *Globigerina conglomerata* Schwager, from the Juan Fernandez Islands.

C. M. I. F. No. 7044-7045.

Globigerina conglomerata Schwager
Plate XLI, figs. 26-27

1866. *Globigerina conglomerata* Schwager, Fossile Foraminiferen von Kar Nikobar; Reise der oesterreichischen Fregatte Novara um die Erde, Geologischer Theil, II, s. 255, Taf. VII, fig. 113, Wien (Reproduced in Galloway's Plates of Foraminifera, IV, p. 35).

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[140] Cushman, J. A., A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 8, 1914.

[141] Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 12, 1924.

[142] Thalmann, H. E., Nomeclator (Um-und Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk uber die Foraminiferen der Challenger-Expedition, London 1884: Ecl. Geol. Helvetiae, XXV, p. 307.

[143] Plummer, Op. cit., p. 133.

1924. *Globigerina bulloides* (?) Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, pl. 2, figs. 1-2.

1926. *Globigerina bulloides* D'Orb., var. *quadripartita* Koch, Mitteltertiäre Foraminiferen aus Bulangan, Ost-Borneo: Ecl. Geol. Helvetiae, XIX, S. 722, Fig. 20a-c, Basel.

1927. *Globigerina quadrilatera* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 44, pl. 7, figs. 11a-c.

1928. *Globigerina quadrata* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 195, pl. 27, figs. 18a-b.

1929. *Globigerina conglomerata* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, figs. 7a-c.

1931. *Globigerina conglomerata* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 117, pl. 14, figs. 5a-c.

Test about quadrate, composed of nine or ten chambers, four of which, much larger than the rest, and regularly increasing in size, form the last whorl. Spire low-depressed. Sutures deeply depressed between chambers of the last-formed whorl, very little so between preceding chambers. Aperture could not be observed. Wall perforate rather coarsely. Length 0.41 mm.; thickness 0.26 mm.

Brady included this species in the synonymy of *Globigerina dubia* Egger,[144] although with some hesitation. Having had a chançe to see Schwager's specimens, he had noticed some inaccuracy in the figures of the latter, but did not explain the defects. Figures of *Globigerina dubia* Egger in Brady's work and those of *Globigerina conglomerata* Schwager, making even a liberal allowance for the incorrectness of the latter, should be recognized to be incomparable. In spite of that, owing to the great authority of Brady, the latter species was almost lost in the literature by being absorbed, however, not by *Globigerina dubia* Egger, but oftener, apparently, by *Globigerina bulloides* D'Orb., as for example, in Cushman's work on the Foraminifera of the Atlantic Ocean. Typical for this species, is the almost quadrate shape of the last-formed whorl, consisting of four large chambers not so gradually increasing in size as do the five chambers of the last-formed whorl in *Globigerina dutertrei* D'Orb., which, according to Thalmann,[145] should be included in the synonymy of the species under consideration. All forms of different localities quoted in the synonymy show well these features, although they vary somewhat in the thickness or the height of the test. All these varieties, however, could not be distinguished as separate species. The Colombian form is particularly like that from the Miocene of Los Sauces Creek.

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[144] Brady, H. B., Op. cit., p. 595, pl. LXXIX, figs. 17a-c. According to Thalmann (Ecl. Geol. Helvetiae, XXV, p. 307) it will be *Globigerina eggeri* Rhumbler.

[145] Ecl. Geol. Helvetiae, p. 307.

As follows from the above synonymy, this species was found in the Upper Cretaceous, in the whole Tertiary system, with the exception of the Oligocene, and is known also in recent oceans. Brady also mentioned that Schwager's specimens were almost identical with the many recent ones.

In the Colombian fauna this species is very rare.

C. M. I. F. No. 7046, 7080.

GLOBIGERINOIDES Cushman

Globigerinoides conglobata Brady

Plate XLI, figs. 30-31

1884. *Globigerina conglobata* Brady, Report on the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, IX, p. 603, pl. LXXX, figs. 1-5, LXXXII, fig. 5, Edinburgh.

1924. *Globigerina conglobata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 18, pl. 3, figs. 8-13, (Synonymy).

1928. *Globigerinoides conglobata* Cushman, Foraminifera, pl. 45, fig. 22.

Test subglobular, composed chiefly of the last three large chambers. Early chambers arranged in the form of a compact spiral. Aperture near the umbilicus. Secondary apertures could be observed only in a few specimens, mostly being obscured by the mineral deposit. Where they could be seen, they were small and few in number. Wall strongly perforate. The greatest diameter 0.4 mm.

Several specimens found in the fauna correspond very closely to the description and figures given by Brady. Lack or rarity of secondary apertures and their small dimensions, when present, can be attributed chiefly to conditions of preservation and practical impossibility to remove remnants of rock matrix. According to Brady, *Globigerina regularis* Reuss,[146] from the Miocene of Austria, is a "somewhat similar form" to that now under consideration. So far, however, as it is possible to judge from figures, the two forms are different.

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[146] Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiärbeckens: Denkschr. d. K. Akad. Wiss., Math. Nat. Wiss. Klasse, I, s. 373, Taf. XLVII, fig. 7a, b, Wien 1850. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126.)

Cushman described this species from two localities of the Gatun Formation, in the Panama Canal Zone.[147] On this occasion he mentioned that the species is almost unknown in fossil condition. It is, however, common in present seas. In the fauna under consideration it is rather abundant.

C. M. I. F. No. 7049-7050.

Family GLOBIGERINIDAE—PULLENIATININAE

PULLENIATINA Cushman

Pulleniatina obliquiloculata Parker & Jones

Plate XLI, figs. 28-29

1865. *Pullenia obliquiloculata* Parker & Jones, On Some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin Bay: Phil. Trans. CLV, p. 368, pl. XIX, figs. 4a, b. London. (Reproduced in Galloway's Plates of Foraminifera, II, p. 128).

1924. *Pullenia obliquiloculata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 43, pl. 8, figs. 10a, b. (Synonymy).

1927. *Pulleniatina obliqueloculata* Cushman, An Outline of a Re-Classification of the Foraminifera: Contr. Cushman Lab., III, p. 90, pl. 19, figs. 5a-b.

Test subglobular, rather irregularly coiled and composed of five swollen chambers, concealing former volutions. Three chambers are seen on one side, four on the other. Sutures depressed, but only moderately. Wall smooth, shiny, finely perforate. Aperture elongate, narrow, curved between the ventral face of the last-formed chamber and the next one. The largest diameter 0.3 mm.

This species is represented in the fauna only by two specimens, of which one is complete. It is distinguished a little from the typical representatives by its somewhat irregular coiling and rather small size.

The species has a very wide distribution in recent seas, but, by most writers, is considered unknown in fossil condition. So far as the writer recollects, it was described as a fossil only by Cushman from the Miocene marl found at a gorge of Yunnuri River, Matanzas, Cuba,[148] where it is rare.

C. M. I. F. No. 7047-7048.

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[147] Cushman, J. A., The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 66, 1918.

[148] Cushman, J. A., Fossil Foraminifera from the West Indies: Carnegie Inst. Wash. Publ. No. 291, p. 40, Washington, 1919.

Family ANOMALINIDAE—ANOMALININAE

PLANULINA D'Orbigny

Planulina bradii sp. n.

Plate XLI, figs. 32-34

1884. *Truncatulina wuellerstorfi* Brady, Report on the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, vol. IX, p. 662, pl. XCIII, figs. 8a-c, Edinburgh.

1931. *Planulina wuellerstorfi* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 110, pl. 19, figs. 5a-c.

Test plano-convex, with dorsal side nearly flat and ventral one almost half ball-shaped, slightly compressed in the middle umbilicate area. Periphery subacute. Chambers to the number of eleven in the last-formed whorl are well distinct on the ventral side, bent, three of them slightly swollen, the last one the most so. Sutures distinctly seen on the ventral side, not so well on the dorsal side, are limbate, curved with an angle, neither raised nor depressed. Aperture at the periphery, extending on the dorsal side along the margin of the chamber in the form of a slit. Surface smooth, glossy, finely perforate. Diameter 0.46 mm.; thickness about 0.22 mm.

As follows from the above synonymy, this species was described by Brady as a variety of *Anomalina wuellerstorfi* Schwager, described by the latter from the Pliocene of Kar Nikobar.[149] Brady figured two varieties, one of which, fig. 9 of his work, he called "the most typical specimen." Another variety, less typical, of his fig. 8, is now under consideration. Recently, Cushman revised Schwager's species and gave new figures of it based on Schwager's material from the type locality[150] corresponding to original figures by Schwager, but different from the figure 8 given by Brady. In Cushman's words: "This is a thick form and not typical." He emphasized also the fact that both varieties described by Brady had been found in different and very distant localities. This one of fig. 8, west of Ireland, and that of fig. 9, on the West Coast of New Zealand. Unfortunately both varieties were often used indiscriminately as representing Schwager's species and, certainly, some misrepresentation has been created in this way as to the systematic scope of this species and its geographical and geological distribution.

[149] Reise der oesterreichischen Fregatte Navara um die Erde, Geologischer Theil, Bd. II, S. 258, Taf. VII, Fig. 105, Wien, 1866. (Reproduced in Galloway's Plates of Foraminifera, IV, p. 35.)

[150] Cushman, J. A., Planulina ariminensis D'Orbigny and P. wuellerstorfi (Schwager): Contr. Cushman Lab. V, p. 104, pl. 15, figs. 1a-c. 2a-c, 1929.

The generic association of Schwager's species also arouses some doubts, which certainly apply to the species under consideration. As Cushman mentioned: "It tends toward Cibicides in many specimens."[151] Many paleontologists bring it into this association.[152] The aperture corresponds exactly to that of *Cibicides* Montfort. General form, especially in the species under consideration, corresponds more to that of *Cibicides* Montfort than to that of *Planulina* D'Orb. The latter, according to Cushman's classification, should have "Test nearly symmetrical."[153] The test, however, is less trochoid than is typical for *Cibicides* Montfort.

C. M. I. F. No. 7051.

Planulina elegans sp. n.

Plate XLI, figs. 35-37

Test plano-convex. Dorsal side flat. Ventral one more or less regularly convex, slightly concave in the middle, corresponding to a shallow umbilicus, and with a shallow spiral depression near the subangulate and keeled periphery. Chambers, nine in the last-formed whorl, well distinct on the ventral side. The last chamber, triangular in shape, strongly swollen. Sutures distinct on the ventral side, limbate, bent with an angle, a little depressed. Aperture not preserved, but, apparently, was at the periphery and extended on the dorsal side. Surface smooth, glossy, finely perforate. Diameter about 0.5 mm.; thickness about 0.16 mm.

This species is rather closely related to *Planulina bradii* m., but can be easily distinguished from it by many features. It is thinner than the former species and its ventral side has a different shape. The periphery is keeled. The chambers are in lesser number, and their shape is a little different. The sutures are a little depressed. *Cibicides dohertyi* Gall. & Morr., from the Upper Eocene of Ecuador, also reminds one of the species under description,[154] but is distinguished from the latter by the biconvex test, slightly lobulate periphery, and larger dimensions.

[151] U. S. Nat. Mus. Bull. 104, part 8, p. 111.

[152] Galloway, J. J. and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 31.

[153] Cushman, J. A., Foraminifera, p. 315, 1928.

[154] Galloway, J. J. and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 30, pl. 4, fig. 7, 1929.

The generic association of *Planulina elegans* m., as in the case of the previous species, is not quite positively fixed. It is quite possible that some paleontologists would be more inclined to bring both species into association with the genus *Cibicides* Montfort rather than with the genus *Planulina* D'Orb.

C. M. I. F. No. 7052.

Family ANOMALINIDAE—CIBICIDINAE

CIBICIDES Montfort

Cibicides risseri White

Plate XLII, figs. 1-3

1928. *Cibicides risseri* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 298, pl. 40, figs. 10a-c.

Test unequally biconvex, with the ventral side almost twice as high as the dorsal one. Dorsal side roundly convex. Ventral side slightly flattened in the middle. Periphery subacute. No sutures can be distinguished on the dorsal side, and only the last whorl is separated here. Eight or nine swollen chambers are seen on the ventral side separated by depressed almost radial sutures. Umbilicus small, shallow. Aperture apparently normal. Diameter about 0.4 mm.; thickness 0.2 mm.

The only difference which it is possible to notice between the Colombian and Mexican forms is in the structure of the dorsal side of the former. The Mexican form shows on the dorsal side distinctly swollen chambers and depressed sutures while the dorsal side of the Colombian form is almost uniformly smooth. *Cibicides risseri* Wh. was described from the middle portion of the Velasco (Upper Cretaceous).

C. M. I. F. No. 7053.

Cibicides pseudoungerianus Cushman

Plate XLII, figs. 4-6

1922. *Truncatulina pseudoungeriana* Cushman, The Foraminifera of the Byram Calcareous Marl at Byram, Mississippi: U. S. G. S. Prof. Paper 129-E, p. 97, pl. XX, fig. 9.

1930. *Truncatulina pseudoungeriana* Cole & Gillespie, Some small Foraminifera from the Meson Formation of Mexico: Bull. Am. Pal. XV, No. 57-b, p. 15, pl. 3, figs. 10-11.

1931. *Cibicides pseudoungeriana* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 123, pl. 22, figs. 3-7.

1933. *Cibicides pseudoungerianus* Ellisor, Jackson Group of Formations in Texas with Notes on Frio and Vicksburg: Bull. Am. A. Petsso. Geol., XVII, pl. 5, figs. 3, 4a-b.

Test trochoid, unequally biconvex, with rounded dorsal side and more conical ventral one. In some specimens the ventral side is about twice as high as the dorsal one. In other cases they are almost subequal. Periphery subacute. Chambers numerous, not less than 10-12 in the last whorl, but they are distinguishable with difficulty on account of the opaque wall. Sutures can be distinguished on the dorsal side in the last whorl only, as all previous whorls are covered with a layer of test material. Most of the sutures are neither raised nor depressed, except the two last ones on the ventral side, which are more or less strongly depressed. The two last chambers are swollen, which gives this species its peculiar shape. Umbilicus filled with the test material. Wall perforated. Aperture peripheral and extends on the dorsal side. Diameter up to 0.5 mm. with thickness about 0.2 mm. or a little more.

The only difference between the Colombian form and those figured by Cushman is that the sutures of the former are a little less distinct. Besides that, the Colombian form is left-handed.

This species was described from the Lower Oligocene of Vicksburg, Mississippi, was found in the Culebra Formation of the Panama Canal Zone,[155] in the Middle Eocene of Mexico, and in the Vicksburg Formation of Texas. It is also a very common recent form.

C. M. I. F. No. 7054-7055.

Cibicides mckannai (?) Galloway & Wissler

Plate XLII, figs. 7-11

1927. *Cibicides mckannai* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 65, pl. 10, figs. 5a-c, 6a-c.

Test trochoid, left- and right-handed, equally, or unequally biconvex. In the latter case the dorsal side is more rounded, but less convex than the ventral one. Chambers numerous, about twelve to the last whorl, uniform in shape, rather narrow. Periphery acute and keeled. Sutures strongly curved on the dorsal side, less so on the ventral one, limbate in both cases. The dorsal side covered with a porous layer of the shell material, which covers the whole surface with the exception of the last whorl, thus obscuring earlier whorls completely. Umbilicus filled with the same material, making a smaller or larger boss, closely fused together with the test. Wall coarsely perforate.

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[155] U. S. G. S. Prof. Paper 129-E, p. 97.

DIMENSIONS IN MM.

	Diameter	Thickness	Relation of the heights of dorsal and ventral sides.
Fig. 11 Left form incomplete	0.54	about 0.3	3:2
Fig. 10 Left form	0.54	over 0.2	1:1
Figs. 7-9 Right form	0.46 and 0.4	over 0.2	4:5

The Colombian form is closely related to the Californian species, and so far as their dorsal sides are concerned they could be considered identical. The ventral side of the latter lacks, however, the raised sutures, which are well developed in the former. This character is considered by Galloway and Wissler to be very important and to distinguish their species from *Cibicides floridanus* Cushman.[156] However, in the most recent description of his species Cushman[157] figured a form with depressed sutures on the ventral side. Both species are undoubtedly very closely related and are distinguishable from each other not as much by the character of their sutures as by the more numerous and narrow chambers of *Cibicides mckannai* Gall. & Wissl., despite the fact that the latter form, in general, is smaller than *Cibicides floridanus* Cushman.

C. M. I. F. No. 7056-7060.

Cibicides colombianus sp. n.

Plate XLII, figs. 12-15

Test unequally biconvex with the dorsal side about twice as low as the ventral one. Periphery angulate, but without a keel. Chambers uniform, numerous, about 10-12 to the last whorl. The early volutions are covered on the dorsal side with a layer of the shell material. Sutures only slightly bent, often inconspicuous, mostly limbate, but neither raised nor depressed. Umbilicus filled with the shell material. Aperture typical for the genus. Wall shining, glossy, perforate. Right- and left-handed forms are present in the collection about in equal number. Diameter of the left figured specimen 0.4 mm.; thickness about 0.2 mm. The right figured specimen is 0.35 mm. in diameter.

In its general shape, this form is closely related to *Cibicides mckannai* (?) Gall. & Wissl., especially as to the smaller specimens of the latter.

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[156] Cushman, J. A., Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 62, pl. XIX, figs. 2a, b, c, 1918.

[157] Cushman, J. A. and Laiming, B., Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 119, pl. 14, figs. 8a-c, 1931.

Its sutures are, however, not protruding as in the latter, also no keel is present, although the periphery is angular.

This species is very common in the fauna under consideration.

C. M. I. F. No. 7061-7062, 7069-7070.

Cibicides atratiensis sp. n.

Plate XLII, figs. 16-18

Test unequally biconvex with the ventral side more than twice as high as the dorsal one. Periphery acute, keeled. Central part of the dorsal side slightly raised on account of a secondary layer of the shell material covering the inner whorls. Chambers numerous up to 13 in the last-formed whorl in a specimen which is less than 0.4 mm. in diameter. Sutures distinct, slightly limbate, but neither raised, nor depressed. Last chamber slightly swollen. Umbilicus filled with the shell material, making a rather strong boss. Aperture apparently typical for the genus. Surface glossy and rather coarsely perforate. Diameter up to 0.4 mm., height less than 0.2 mm.

In its general shape, this species reminds one of *Cibicides colombianus* m., but it has a keel, which the latter lacks. The number of chambers in the last whorl of *Cibicides atratiensis* m. is also a little greater than in the latter. The same characters distinguish this species from *Cibicides pseudoungerianus* Cushman, described above, in common with which this species has swollen last chambers. The difference from the latter species is, however, even greater than in the former case, since Cushman's species, while being a little larger than this one under consideration, has less chambers in the last-formed whorl.

C. M. I. F. No. 7063-7064.

Cibicides depressus sp. n.

Plate XLII, figs. 19-21

The dorsal side of the test slightly concave. Ventral side rather strongly convex, especially in the left variety, less so in the right one, slightly depressed or even umbilicate at the center. Peripheral margin rather acute. Chambers numerous, but not well distinguished. Ten to twelve could be assigned to the last whorl. Chambers of the inner whorl, nine in number, are seen on the dorsal side of the left variety in the form of faint punctations. Only a few of them can be distinguished on the dorsal side of the right variety. Sutures are thin, slightly depressed and rather indistinct. Wall smooth, even glossy in the right variety, finely perforate. Aperture on the lower side near the edge goes over to the dorsal side in the form of a slit.

DIMENSIONS IN MM.

	Two Diameters	Thickness
R.	0.32 and 0.41	0.14
L.	0.41 and 0.51	0.22

This species reminds one of *Cibicides lobatulus* Walk. & Jac.,[158] particularly the varieties figured by Brady,[159] but is well distinguishable from the latter by its more numerous chambers, although its general dimensions are much smaller. It is entirely different from the very lobate forms figured by Walker with which, also, the forms figured by Brady could hardly be connected. It is possible, however, that the lobate structure was much exaggerated on the original figures. Recent *Cibicides* sp. from the Juan Fernandez Islands, particularly the form represented on fig. 4 of Cushman and Wickenden's paper, is apparently closely related to the species under consideration.[160]

C. M. I. F. No. 7065-7066.

Cibicides concavus sp. n.

Plate XLII, figs. 22-24

Test concavo-convex, with the dorsal side slightly concave and ventral side roundly convex. Umbilicus narrow, with a small but distinct plug. Peripheral margin subacute. Chambers, eight in number, increase in size with the growth of the test, the last two of them being particularly large and rather irregular. Sutures a little limbate, and on the ventral side slightly depressed. Aperture not preserved, although some markings near the edge on the dorsal side may be considered the remnant of the upper slit. Wall glossy, finely perforate. Diameter in two directions 0.54 mm. and 0.46 mm.; thickness 0.15 mm.

Cibicides concavus m. is distinguished from *Cibicides lobatulus* Walk. & Jac.,[161] with which this species is closely related, by lack of lobation and by the presence of the well expressed plug in the umbilicus. The presence of the plug and the lesser number of chambers distinguishes it, also, from *Cibicides depressus* m.

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[158] Walker, G., Testacea minuta rariora etc., p. 20, pl. III, fig. 71, London, 1784. (Reproduced in Galloway's Plates of Foraminifera, I, p. 19).

[159] Brady, H. B., Op. cit., p. 660, pls. XCII, fig. 10; XCIII, figs. 1a-c, 4, 5; CXV, figs. 4, 5.

[160] Cushman, J. A. and Wickenden, R. T. D., Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc., 75, art. 9, p. 15, pl. 6, figs. 4, 8, 1929.

[161] Walker, G., Op. cit.

C. M. I. F. No. 7067.

Cibicides nephridium sp. n.

Plate XLII, figs. 25-27

Test plano-convex, oval. Dorsal side almost flat or a little convex, being about five times lower than the ventral one. Peripheral margin round. Of seven chambers present, the two last ones are large. Sutures are somewhat limbate, made of the transparent shell material, and rather well distinguished. The last one is somewhat depressed, others are on the level of the test. Umbilicus closed with a comparatively large plug hardly separated from the surface of the ventral side. Aperture on the ventral side close to the peripheral margin and extending over onto the dorsal side. Wall finely perforated. Diameters in two directions equal 0.46 mm. and 0.36 mm.; thickness 0.16 mm.

This species is related also with *Cibicides lobatulus* Walk. & Jac.,[162] but is distinguished by the lack of lobation, by the flat or somewhat convex dorsal side, and by the presence of a plug in the umbilicus. It is possible, also, that it was a free form not attached by its dorsal side. Its general shape distinguishes it from *Cibicides concavus* m. with which it has in common the number of chambers and a plug in the umbilicus.

C. M. I. F. No. 7068, 7081.

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[162] Walker, G., Op. cit.

DESCRIPTION OF THE FLORA

ANGIOSPERMAE—DICOTYLEDONEAE

SPERMITES Saporta

Spermites fragilis sp. n.

Plate XLII, figs. 37-39

A small hollow fragment of a crescent shape which suggests an ovoid body slightly and somewhat unsymmetrically compressed laterally. Surface smooth, aside from a few erosion marks, and a small elliptical ring on the round end—a trace of some kind of an attachment. The shell is rather thick on the round end, becomes thinner, although still comparatively thick, toward the horns of the crescent, but was probably thin on both sides. The other broken-off end had probably a similar structure. The interior of the shell is smooth with the exception of a slightly marked scar at the thicker end. Estimated length was probably about 1.5 mm.; width 1.1 mm.; thickness 0.7 mm.

The described fragment is all that is present for the identification of this interesting fossil, the interpretation of which, even a quite hypothetical one, caused much trouble and study. It would be easier and perhaps more reasonable not to bother about this fragment at all and leave it without any description, but it would be, however, a real pity not to mention it.

Among Foraminifera there are several genera with a single chambered test to which, apparently, it would be possible to refer the specimen under consideration. All those genera have, however, the test more or less ball-shaped or flask-like and, when regular, are radially symmetrical. The test is usually arenaceous and uniformly thick. When parts of the wall are thicker than usual, they are distributed irregularly.

The fragment under consideration is bilaterally symmetrical. Its test is homogeneous. Variations of thickness are regular and distributed according to the general shape of the fossil and its symmetry. The inside scar and the outer attachment-spot do not find anything analogous in the Foraminifera. Relationship to the Foraminifera cannot, therefore, be accepted for this fragment.

Besides Foraminifera, there are no animal forms with which this interesting form could be compared. Its bilaterally symmetrical shape, inner scar, and outer attachment-spot, remind one of some seeds of the Dicotyledoneae. It hardly might be, however, a shell of a seed because, in that case, the shell would have a rather uniform thickness and not have such a strong and regular variation of thickness as observed in the fragment under consideration. It may be, however, a fragment of an inner cast of a seed. In this case the inner cavity may be interpreted as a mould of the embryo and the whole fragment as a cast of the endosperm.[163]

It is hardly possible to identify this fragment more exactly than has been done above, particularly to establish any relationship with some genus of Dicotyledoneae. The generic name *Spermites* may be, however, well applied to the form under consideration because this provisional genus was established by Saporta[164] for "Toutes les graines de nature indéterminée" described by him in the fossil flora of Aix-en-Province under three specific names. Every one of these species might be identified, eventually, in a proper way and find its association with some other genus. The emergency genus *Spermites* would thus become, in this way, a *nomen nudum*. Excepting by Saporta, himself, this generic name was never used by any other paleophytologist and is practically lost in paleobotanical literature. At least, the writer was unable to find a reference to it in the literature available to him. In the catalogue of the National Museum there are only the names of three species described by Saporta at the time of publication of the generic name.[165] It was used by Saporta in a case of emergency and in this sense is used in the present paper. In spite of the very fragmentary condition of the only specimen, its specific independence can be considered well established.

(C. M. Paleophytological collection).

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[163] The writer feels greatly obliged to Dr. O. E. Jennings of Carnegie Museum for the friendly help given in disclosing the nature of this interesting fossil.

[164] Saporta, M. G. de, Dernières adjonctions à la flore fossile d'Aix-en-Province (2 ième partie): Ann. Sc. Nat., 2 Sér., Botanique, II, p. 142, Paris, 1889.

[165] For this information the writer is obliged to Dr. David White of the U. S. Geological Survey.

ALGAE

CORALLINACEAE

LITHOTHAMNIUM Philippi

Lithothamnium colombianum sp. n.

Plate XLII, figs. 40-43; pls. XLIII and XLIV

Among different pebbles separated out of the rock examined there were numerous limestone pebbles mostly of a more or less regular, elongated, rounded shape, sometimes subcylindrical, often irregular, although still rounded. They attain the length of 5 mm., but most of them are smaller. Treatment with HCl and examination of thin slides revealed the structure typical for the *Corallinaceae.* The shape of their thallus is unknown. However, the shape of some such pebbles, although rolled out in water, would depend clearly on the original form of the thallus, and would be determined, also, by the connection between the exterior form and their inner structure. All pebbles examined were undoubtedly short rounded branches protruding, probably, from the exposed face of the alga, which is not preserved in such a complete manner. Owing to the conditions of preservation, no slide showed the structure of the whole thallus. The microstructure of the hypothallium and perithallium, however, could be observed separately in different slides.

Both hypothallium and perithallium are composed of numerous concentric layers of cells, but the hypothallium could be distinguished by its "coaxial" structure, composed of rows of cells radiating out from a central point and by the absence of conceptacles, also by more regular concentric structure. The cells of the hypothallium are a little longer in the direction of their radiation than in their width, the dimensions being correspondingly 0.015-0.018 mm. by 0.011 mm. The cells of the perithallium are a little smaller than those of the hypothallium, subquadrate, or sometimes even a little broader than high, measuring about 0.011 mm. in diameter. Their height does not exceed 0.012 mm. and width 0.009 mm. Conceptacles are few, distributed irregularly, being embedded within the perithallium. Their identification as such is not absolutely certain. Two of them measured 0.30 mm. by 0.42 mm., and 0.13 mm. by 0.25 mm.

By its micro-structure the species under consideration reminds one very closely of *Lithothamnium isthmi* Howe,[166] from the Emperador limestone (Oligocene) of the Panama Canal Zone. The only difference between these two species is a little smaller size of the cells in the one from Colombia. The size of the cells in *Lithothamnium isthmi* Howe, however, is very variable and some of them correspond in size to the dimensions given above. The rather narrow limits of the size of cells of *Lithothamnium colombianum* m. perhaps might be explained by the somewhat scarce material. With more abundant material it might be possible to meet with a greater variability in the size of cells in the Colombian form than is observed now. It might then, eventually, be necessary to bring both species together under the same specific name *Lithothamnium isthmi* Howe.

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[166] Howe, Marshall A., On some Fossil and Recent Lithothamnieae of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 8, pl. 7, fig. 3; plates 9, 10 and 11. 1918.

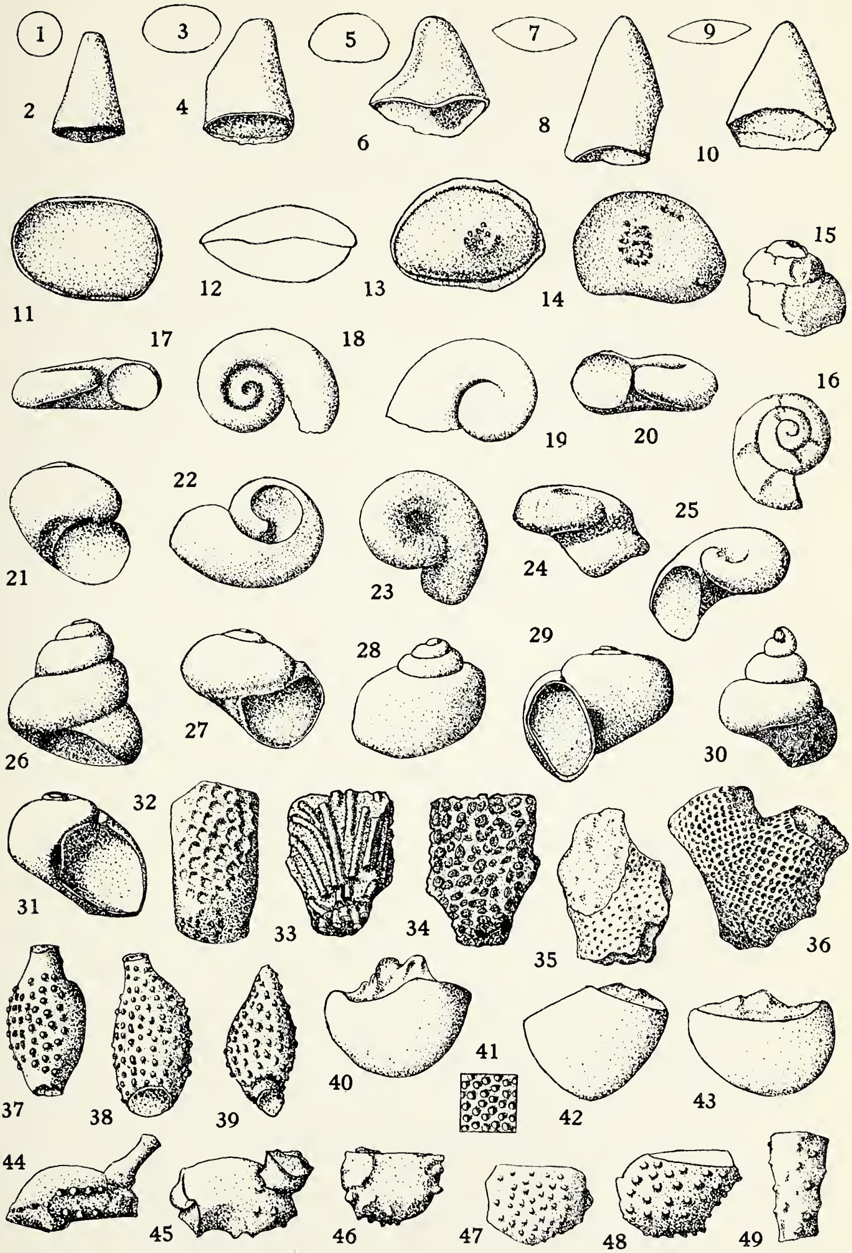
(C. M. Paleobotanical collection).

EXPLANATION OF PLATE XXXIX*

Figs. 1- 6.	*Scombramphodon* (?) sp. Figs. 1-2. Cross section and lateral view of one specimen (5423) x 43. Figs. 3-4. Another specimen (5424) x 40. Figs. 5-6. The third specimen (5425) x 50.
Figs. 7-10.	*Scombramphodon* (?) sp. Figs. 7-8. Cross section and lateral view of one specimen (5426) x 28. Figs. 9-10. Another specimen (5427) x 28.
Figs. 11-14.	*Cytherella atrata* sp. n. Figs. 11-12. Left side and ventral view of a complete specimen (6945) x 30. Figs. 13-14. Left and right views of an inner cast (6946) x 27.
Figs. 15-16.	*Trochus* sp. Side and apical views (6947) x 60 and 50.
Figs. 17-18.	*Turbo* sp. Apertural and apical views (6948) x 40.
Figs. 19-20.	*Turbo* sp. Apical and apertural views (6949) x 50.
Figs. 21-24.	*Turbo* sp. Figs. 21-22. Side and apical views of one specimen (6951) x 45. Figs. 23-24. Apical and side views of another specimen (6952) x 46 and 58.
Fig. 25.	*Turbo* sp. Apical view (6954) x 67.
Fig. 26.	*Trochus* sp. Side view (6955) x 67.
Fig. 27.	*Natica* sp. Apertural view (6957) x 54.
Fig. 28.	*Natica* sp. Side view (6958) x 46.
Fig. 29.	*Natica* sp. Apertural view (6960) x 46.
Fig. 30.	*Hydrobia* sp. Side view (6961) x 28.
Fig. 31.	*Natica* sp. Apertural view (6963) x 42.
Fig. 32.	*Heteropora elliptica* sp. n. (6965) x 7.
Figs. 33-34.	*Heteropora* sp. Natural section and natural surface with irregularly shaped orifices (6967) x 14.
Fig. 35.	*Heteropora* (?) *amalgamata* sp. n. Fragment of zoarium (6969) x 6.
Fig. 36.	*Heteropora* sp. Fragment of zoarium (6970) x 9.
Figs. 37-49.	*Asterias* (?) *huntleyi* sp. n. Figs. 37-39. Supposed jaws of pedicellariae (6972-6974) x 45, 40, 36. Figs. 40, 42, 43. Supposed basal plates of pedicellariae (6976-6978) x 54, 72, 65. Fig. 41. Enlarged sculpture of the specimen of fig. 43. Figs. 44-45. Plates bearing a spine (6979-6980) x 42. Figs. 46-48. Fragmentary dermal plates (6986-6988) x 33. Fig. 49. Fragment of spine (6982) x 30. S. pl. XLII, figs. 32-34.

*The numbers in brackets refer to the catalogs of fossils of the Carnegie Museum. The enlargements given above are always only approximate.

Plate XXXIX.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EXPLANATION OF PLATE XL*

Fig. 1. *Chiridota* (?) sp.
(6990) x 12.

Figs. 2- 3. *Bathysiphon* (?) sp.
(6991-6992) x 20.

Figs. 4- 5. *Verneuilina fusiformis* sp. n.
Side view and horizontal section x 33.

Figs. 6- 7. *Verneuilina* sp.
Horizontal section and side view (6994) x 50.

Figs. 8-10. *Quinqueloculina seminula* Linnaeus
Inner cast, side view of a complete specimen and aperture of another specimen (6996-6998) x 41.

Figs. 11-12. *Lenticulina rotulata* Lamarck
Cross section and lateral view (7000) x 48.

Fig. 13. *Lenticulina multiseptae* (?) Berry
(7002) x 18.

Figs. 14-15. *Lenticulina colombiana* sp. n.
Lateral and apertural views (7003) x 7.

Figs. 16-17. *Lenticulina lens* sp. n.
Apertural and lateral views (7005) x 14.

Figs. 18-19. *Lenticulina orbicularis* D'Orbigny
Lateral and apertural views (7006) x 24.

Figs. 20-21. *Robulus lenticularis* sp. n.
Apertural and lateral views (7008) x 37.

Figs. 22-23. *Dentalina pauperata* D'Orbigny
Lateral and upper views (7010) x 24.

Fig. 24. *Dentalina* sp.
(7011) x 24.

Fig. 25. *Dentalina* sp.
(7012) About natural size.

Figs. 26-27. *Elphidium crispum* Linnaeus
Vertical section and lateral view (7014) x 48.

Fig. 28. *Buliminella pulchra* sp. n.
(7016) x 45.

Fig. 29. *Bulimina affinis* D'Orbigny
(7017) x 30.

Figs. 30-31. *Siphogenerina transversa* Cushman
Lateral and top views (7018) x 36.

Fig. 32. *Discorbis floridensis* Cushman
(7020) x 27.

Figs. 33-34. *Discorbis atratiensis* sp. n.
Upper and lower side views (7021) x 38.

Figs. 35-37. *Gyroidina soldanii* D'Orbigny
Apertural, dorsal, and ventral views (7022) x 43.

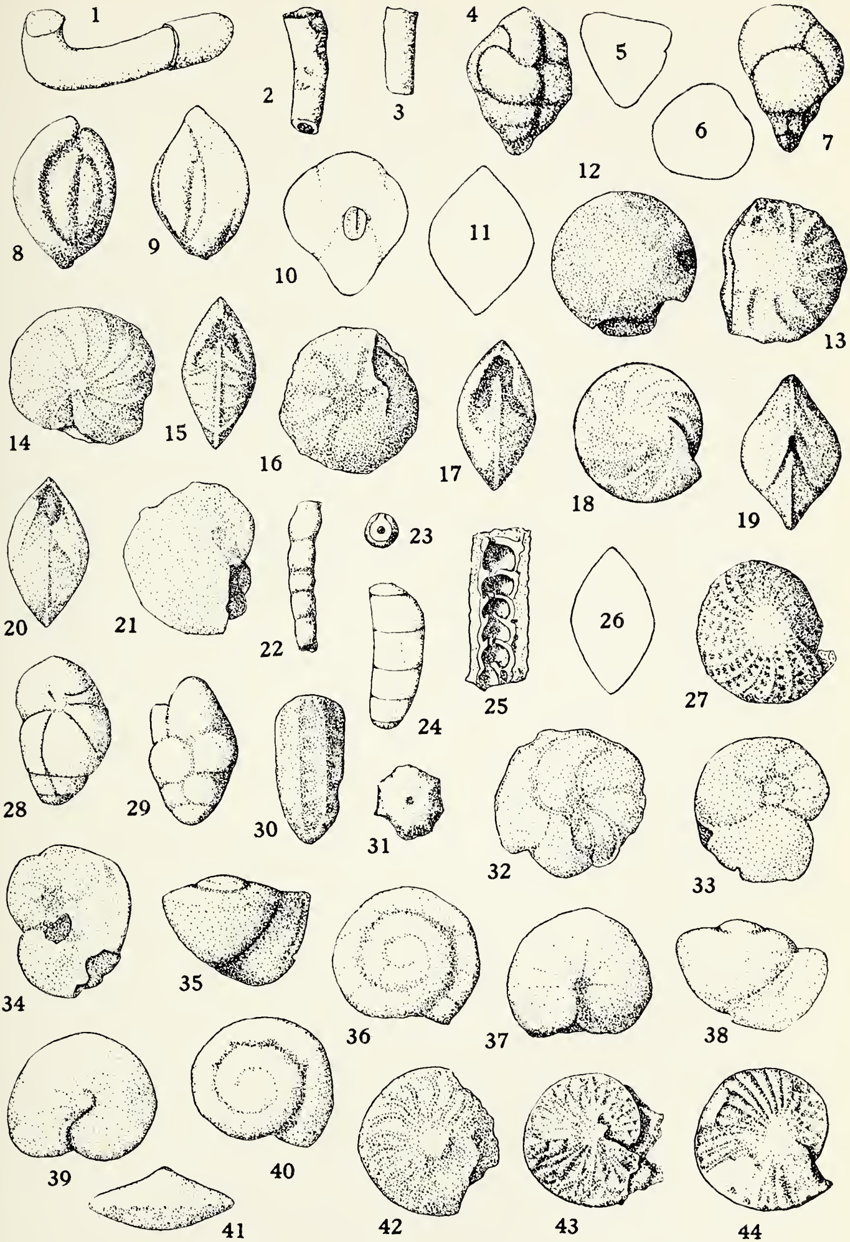
Figs. 38-40. *Gyroidina* sp.
Apertural, ventral, and dorsal views (7023) x 55.

Figs. 41-42. *Amphistegina haueriana* D'Orbigny
Lateral and dorsal views (7024) x 17.

Figs. 43-44. *Amphistegina lessoni* D'Orbigny
Ventral views of two inner casts (7026-7027) x 12.

*The numbers in brackets refer to the catalogs of fossils of the Carnegie Museum. The enlargements given above are always only approximate.

Plate XL.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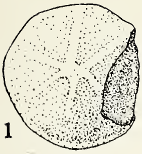
EXPLANATION OF PLATE XLI*

Figs. 1- 3.	*Eponides antillarum* D'Orbigny Ventral, lateral, and dorsal views (7029) x 28.
Figs. 4- 6.	*Eponides praecinctus* Karrer. Ventral, dorsal, and apertural views (7031) x 40.
Figs. 7- 9.	*Eponides limbatus* sp. n. Dorsal, ventral, and lateral views (7033) x 50.
Figs. 10-12.	*Eponides* sp. Ventral, dorsal, and lateral views (7034) x 48.
Figs. 13-15.	*Siphonina antiguiensis* sp. n. Inner cast. Ventral, dorsal, and apertural views (7036) x 38. S. pl. XLII, figs. 28-29
Figs. 16-18.	*Siphonina chocoiensis* sp. n. Ventral, apertural, and dorsal views (7037) x 48.
Figs. 19-20.	*Globigerina bulloides* D'Orbigny Ventral and dorsal views (7038) x 55.
Fig. 21.	*Globigerina tricamerata* sp. n. (7040) x 60.
Figs. 22-23.	*Globigerina trilocularis* D'Orbigny Ventral and dorsal views (7042) x 63.
Figs. 24-25.	*Globigerina dutertrei* D'Orbigny Ventral and dorsal views (7044) x 57.
Figs. 26-27.	*Globigerina conglomerata* Schwager Ventral and dorsal views (7046) x 50.
Figs. 28-29.	*Pulleniatina obliquiloculata* Parker & Jones Two side views (7047) x 67.
Figs. 30-31.	*Globigerinoides conglobatus* Brady Two side views (7049) x 55.
Figs. 32-34.	*Planulina bradii* sp. n. Dorsal, ventral views, and cross section (7051) x 43.
Figs. 35-37.	*Planulina elegans* sp. n. Ventral view, cross section, and dorsal view. (7052) x 44.

*The numbers in brackets refer to the catalogs of fossils of the Carnegie Museum. The enlargements given above are always only approximate.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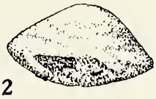
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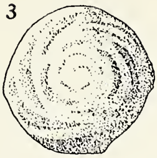
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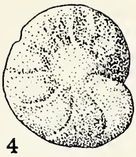
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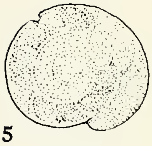
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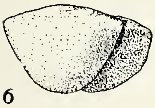
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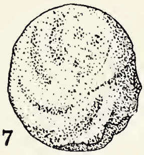
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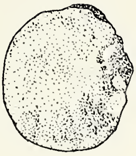
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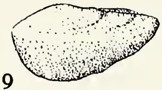
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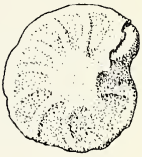
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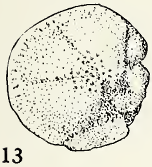
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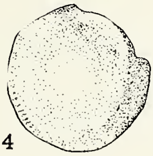
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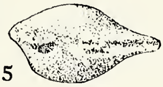
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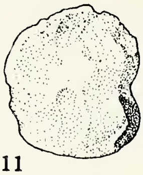
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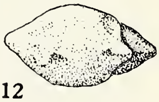
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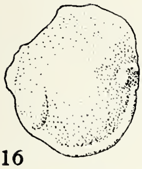
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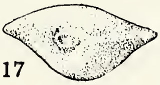
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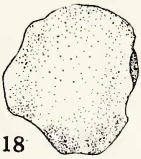
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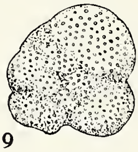
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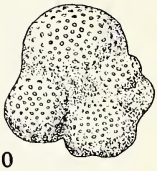
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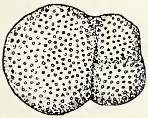
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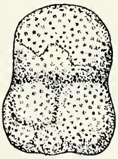
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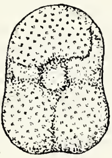
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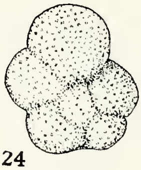
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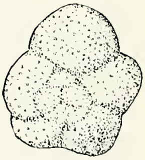
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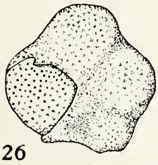
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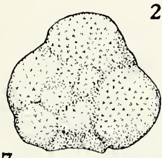
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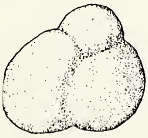
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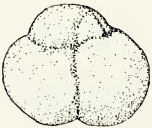
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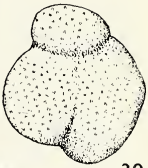
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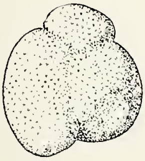
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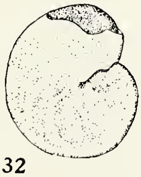
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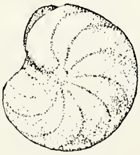
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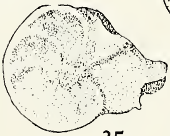
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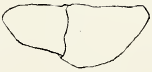
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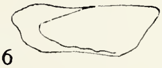
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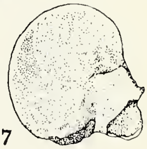
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EXPLANATION OF PLATE XLII*

Figs. 1- 3. *Cibicides risseri* White.
Dorsal and ventral view and cross section (7053) x 52.

Figs. 4- 6. *Cibicides pseudoungerianus* Cushman.
Dorsal and ventral views and cross section (7054) x 42, 42, 48.

Figs. 7-11. *Cibicides mckannai* (?) Galloway & Wissler.
Figs. 7-9. Dorsal view, cross section and ventral view (7056) x 45. Figs. 10-11. Cross sections of two left forms (7057, 7058) x 37.

Figs. 12-15. *Cibicides colombianus* sp. n.
Figs. 12-14. Cross section, dorsal and ventral views of a left specimen (7061) x 50. Fig. 15. Outline of the dorsal side of a right specimen (7062) x 58.

Figs. 16-18. *Cibicides atratiensis* sp. n.
Dorsal view, cross section and ventral view (7063) x 54.

Figs. 19-21. *Cibicides depressus* sp. n.
Dorsal view, cross section and ventral view of a left form (7065) x 40.

Figs. 22-24. *Cibicides concavus* sp. n.
Cross section, dorsal and ventral views (7067) x 40.

Figs. 25-27. *Cibicides nephridium* sp. n.
Dorsal and ventral views and cross section (7068) x 45.

Figs. 28-29. *Siphonina antiguiensis* sp. n.
Ventral side and lateral (apertural) views (7071) x 32.
S. pl. XLI, figs. 13-15

Figs. 30-31. *Quinqueloculina subquadrata* sp. n.
Cross section and lateral view (7073) x 71.

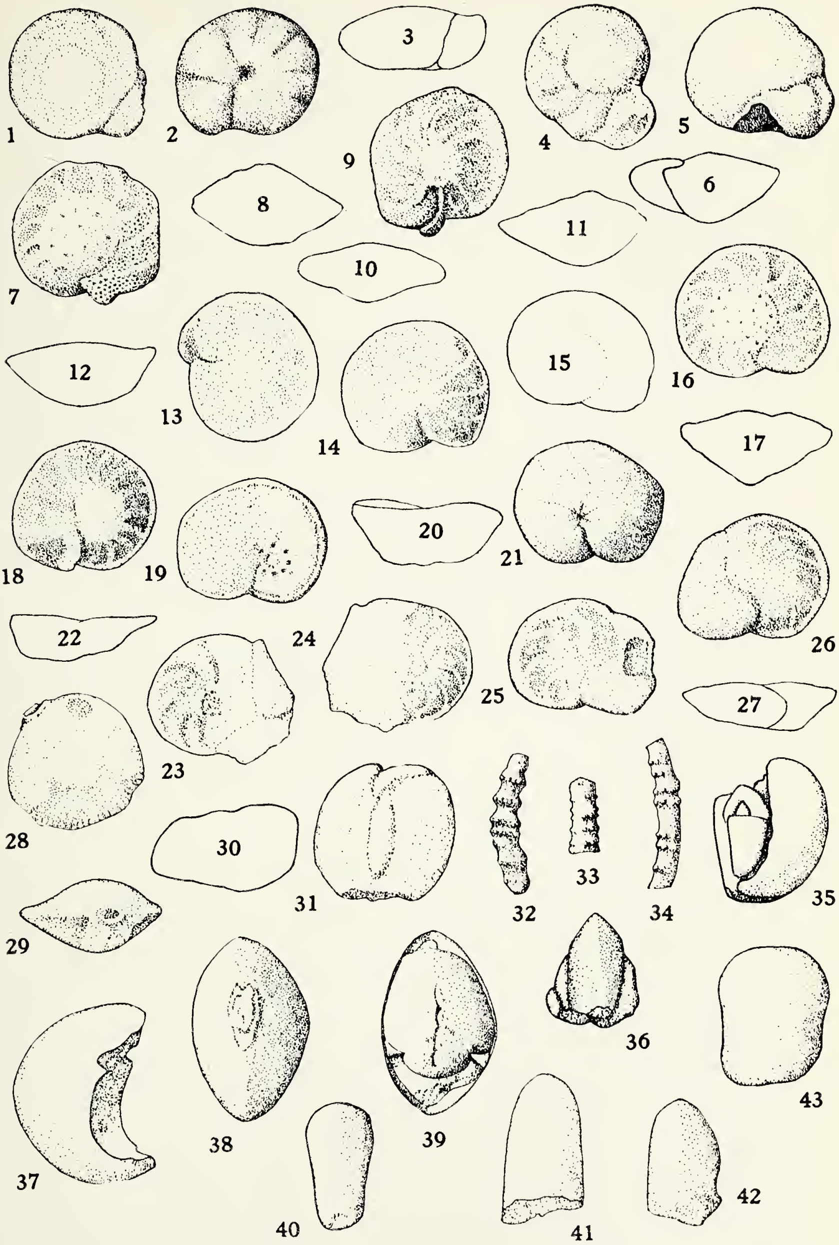
Figs. 32-34. *Asterias* (?) *huntleyi* sp. n.
Three spines referred to this species with some doubt (7074-7076) x 38. S. pl. XXXIX, figs. 37-49

Figs. 35-36. *Quinqueloculina auberiana* D'Orbigny
Fragmentary inner cast (7072) x 60.

Figs. 37-39. *Spermites fragilis* sp. n.
Side, frontal and inner views (C. M. paleophytological collection) x 20.

Figs. 40-43. *Lithothamnium colombianum* sp. n.
Four algal pebbles (C. M. paleobotanical collection) x 5.
S. pls. XLIII and XLIV

*The numbers in brackets refer to the catalogs of fossils of the Carnegie Museum. The enlargements given above are always only approximate.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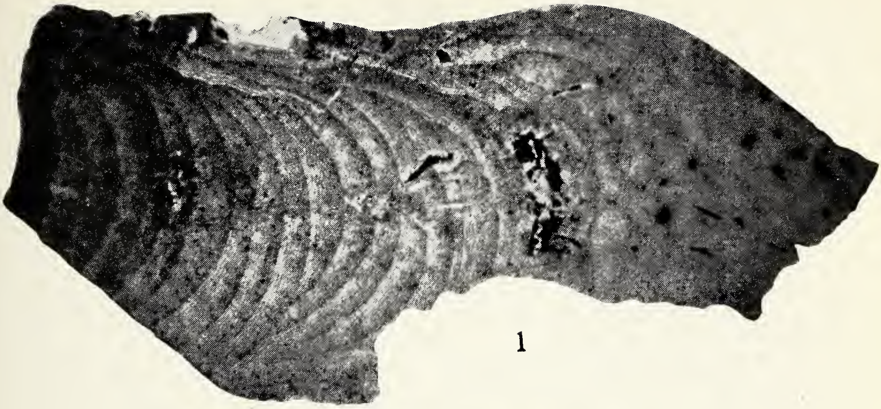
EXPLANATION OF PLATE XLIII

Figs. 1- 2. *Lithothamnium colombianum* sp. n.

Fig. 1. Section of the hypothallium pebble x 26. Fig. 2. Section through the hypothallium x 180. (C. M. Paleobotanical collection.) S. pl. XLII, figs. 40-43, and pl. XLIV



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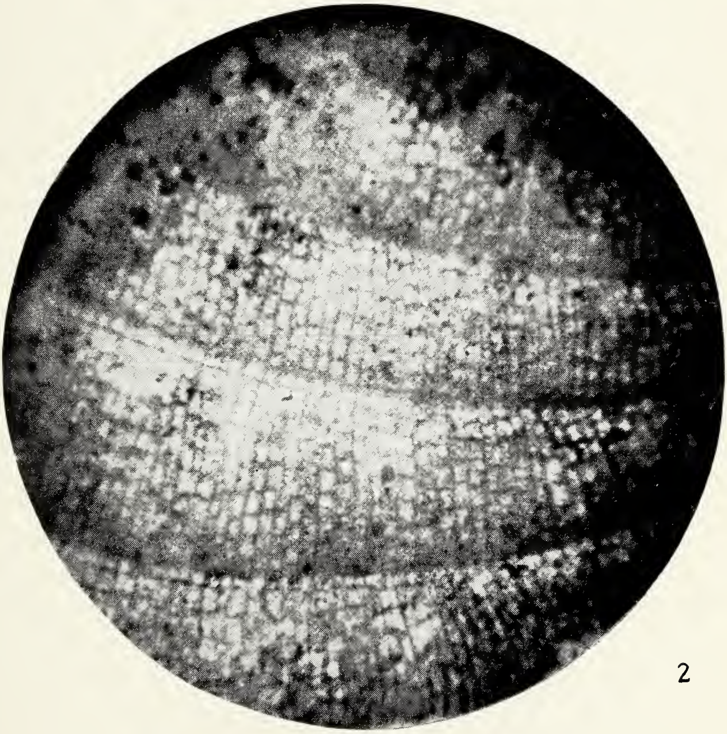

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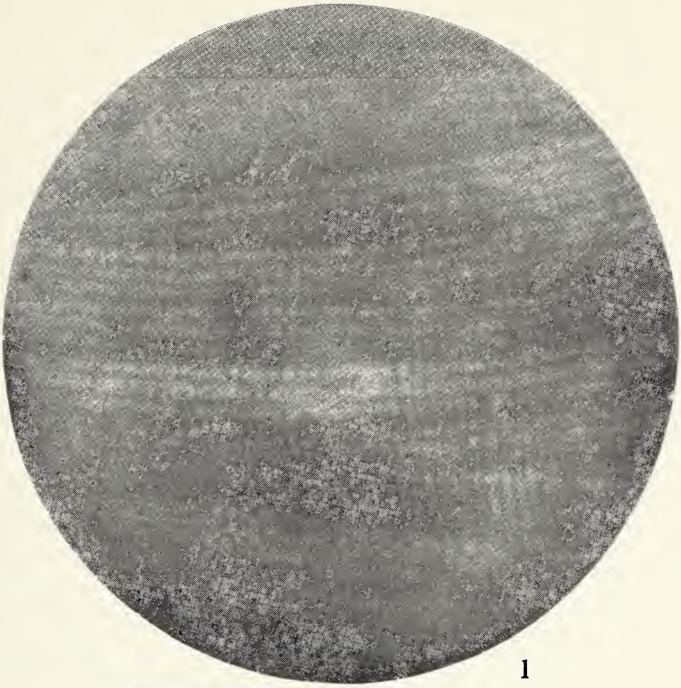
EXPLANATION OF PLATE XLIV

FIGS. 1- 3. *Lithothamnium colombianum* sp. n.

Fig. 1. Section through the perithallium x 180. Fig. 2. Section of the perithallium pebble with conceptacles x 36. Fig. 3. Conceptacles in another rather thick section, not showing therefore the celluar structure of the perithallium x 36. (C. M. Paleobotanical collection.) S. pl. XLII, figs. 40-43, and pl. XLIII



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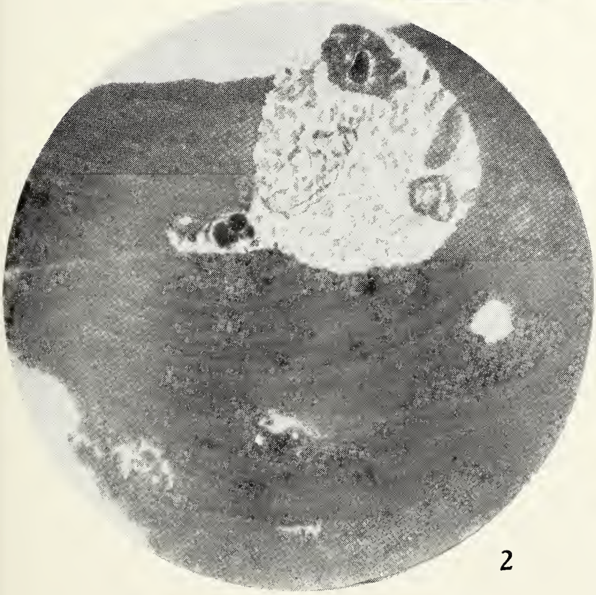

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VI. THE TERTIARY FORMATIONS OF THE UINTA BASIN, UTAH

By J. LeRoy Kay

In 1931 Peterson and Kay[1] made a geological map and cross-section of the Tertiary deposits in the eastern part of the Uinta Basin, Utah. During the season of 1932, the writer, assisted by J. J. Burke and Mather Eliot, gathered data for extending this map to include the western part of the district. The accompanying map thus shows the principal roads, townships, meridians, and the extent of the Tertiary formations in the central and northern part of the basin; it also shows some of the localities from which the Carnegie Museum field parties have made fossil collections.

While most of the time in the field was spent in making collections and studying the Tertiary formations, a few side trips were made into the canyons leading back into the Uinta Mountains where the older rocks are exposed. In the month of August Dr. I. P. Tolmachoff, Curator of Invertebrate Paleontology at the Carnegie Museum, joined the party and collections of invertebrates were made from the Mississippian, Pennsylvanian, Permian, Jurassic, Cretaceous, and Tertiary strata.

The writer wishes to make acknowledgments to Mr. Childs Frick and to Dr. George H. Clapp, whose generosity in rendering financial assistance made this work possible; to the late O. A. Peterson for directing the work; to Prof. W. B. Scott for his advice concerning a new stratigraphic term; to Mr. J. J. Burke and to Mr. Mather Eliot for their ever-ready assistance in the field.

DUCHESNE RIVER (OLIGOCENE) FORMATION

The name "Duchesne" was proposed by Professor W. B. Scott, for the Lower Oligocene Formation of the Uinta Basin, Utah, and was so used by him in the third edition of his text book, "An Introduction to Geology," 1932. Duchesne has been used in several publications

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[1] Peterson, O. A. and Kay, J. LeRoy. The Upper Uinta Formation of Northeastern Utah. Annals Carnegie Museum, Vol. XX, pp. 293-305. June 1931.

Issued October 15, 1934

by the Carnegie Museum. It appears that the name Duchesne is preoccupied, having been used by Keyes[2] for a limestone of Jurassic age. This duplication is rather unfortunate. A new name is required for the Oligocene formation in Utah, but the writer feels that there will be less confusion if the word "Duchesne" is retained in the new term. At Prof. Scott's suggestion the name **Duchesne River** is now proposed for the lower Oligocene formation of the Uinta Basin, Utah.

The Duchesne River Formation to the south lies conformably upon Horizon C of the Uinta Eocene, but with greater or less unconformity with the older rocks along its northern border. It is composed chiefly of alternating bands of sandstones and red, brown, and variegated clays, the sandstones often inclosing lenses of arenaceous clays. Many of the clay members are deceptive as to their thickness. In weathering out they cover the sandstones below and appear to be several feet in thickness but if the surface is cleaned off, they are found to be only a few inches thick. The surfaces of the sandstones are more or less stained by these clays and appear to be reddish-brown in color, but are mostly grey or very light brown. In looking at the beds as a whole they appear a brick red. The sandstones predominate and are often conglomeratic.

At Rock Creek, where the cross-section of the western part of the Uinta Basin was made, the Duchesne River Formation has a thickness of over fifteen hundred feet, which is probably the maximum thickness. The greatest north-south extent of this formation is east of Lake Fork.

In most places along the northern border, at or near the base of the Duchesne River sediments, heavy bedded, coarse conglomerates occur. These conglomerates probably attain their greatest thickness at Currant Creek but are well exposed at Lake Fork where they rest with a slight southern dip upon the Triassic and Jurassic. The latter formations at this point have a dip of about sixty degrees. (See Pl. XLVII)

In the Asphalt Ridge, about five miles south and west of Vernal, below the lowermost conglomerate, specimens were found and identified by O. A. Peterson as lower Oligocene Agriochœrids. (See Pl. XLVIII) Thus it appears that these conglomerates cannot always be considered the base of the Duchesne River Formation.

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[2] Keyes, C. R. Grand Staircase of Utah. Pan. Am. Geo., Vol. 41, Feb. 1925, p. 36.

Along the northern border, the contact of the Duchesne River with the older rocks is more or less obscured by re-worked glacial gravels which cap most of the benches and only in a few places are they consolidated. In several places, lying beneath the Duchesne River Formation, are exposed strata of undoubtedly Eocene age. Although these beds were prospected no identifiable fossils were found. The best exposures are between Rock Creek and the Duchesne River; Lupton[3] maps them as Wasatch. The writer is inclined to regard them as Uinta. This conclusion is based chiefly on their lithological character.

To facilitate correlation and reference of specimens now in the Carnegie Museum, the Duchesne River Formation is divided into three horizons. These are, from lowest to highest, the **Randlett**, the **Halfway**, and the **Lapoint**. The type locality for the Randlett Horizon (See Pl. XLIX) is north and east of the town of that name and consists of 478½ feet[4] of brown, red, bluish grey and variegated clays alternating with brown and grey sandstones. These beds are capped by a ten foot stratum of conglomerate (No. 192, East section) which is taken as the base of the Halfway Horizon.

The strata of the Halfway Horizon are well exposed along Halfway Hollow, the basin which drains that district in townships four and five south, between ranges nineteen and twenty east Salt Lake meridian. There are 557½ feet[4] of sediments referred to this horizon, consisting chiefly of sandstones and shales with several conglomerate members. The standstones in general are coarser than those of the Randlett. Overlying the Halfway is a layer, twenty-two feet thick, of bluish white clay (No. 219, East section), which can be seen just north of the Vernal-Lapoint Road and is quite persistent throughout the area. This is considered the basal member of the Lapoint.

The Lapoint, the uppermost division of the Duchesne River Formation, is typically observed along the head of Halfway Hollow east and north of the town of Lapoint. This horizon includes 336 feet[4] of sandstones, clays, and conglomerates. The conglomerates are coarse, the sandstones conglomeratic, and the shales quite sandy.

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[3] Lupton, Charles I. The Deep Creek District of the Vernal Coal Field, Uinta County, Utah. U. S. G. S. Bull. 471, pp. 579-594.

[4] These measurements are taken from a lithological section made by J. LeRoy Kay in 1929. Peterson, O. A. and Kay, J. LeRoy, The Upper Uinta Formation of Northeastern Utah. Annals Carnegie Museum, Vol. XX, pp. 301-306. June 1931.

UINTA FORMATION

The Uinta Tertiary occupies the central part of the Basin overlying the Green River on the south and underlies the Duchesne River Formation on the north. It is composed of fine and coarse-grained sandstones and indurated arenaceous shales and clays.

Peterson[5] divided these deposits into horizons A (lower), B (middle), and C (upper), including what is now called Duchesne River, as part of Horizon C. Douglass[6] measured these three horizons in the eastern end of the Basin as follows: A, 685 feet, questioning whether the lowermost 170 feet should be included in horizon A or left in the underlying Green River Formation, and B, 420 feet. He measured these two horizons at a point near the Uinta Railway Stage Road in Wagon Hound Canyon (Tps. 9 & 10, S. R. 24, E. S. L. M.). Douglass partly measured Horizon C about fifteen miles further to the west, beginning at a point near White River and proceeding west of North to the top of Deadman Bench, 1,440 feet. He estimated the total thickness to be not less than 2,000 feet, including what is now known as Duchesne River Formation. Measurements by Peterson and Kay from Willow Creek to Little Mountain give the beds a thickness of 3,025 feet. They include the lower 170 feet, in Horizon A, which Douglass held in question. At the head of Happy Canyon where the White River-Willow Creek Road leaves the bench to descend to the valley of the Willow Creek, there is a stratum of sandstone twenty feet thick, partly laminated, which Peterson and Kay consider the top of Horizon A.[7] These sandstones weather into small buttes with copper-stained summits in the low valley to the north. While these sandstones are quite persistent in this locality the writer was unable to recognize them in the western part of the Basin.

Horizon B differs from A by having less sandstones and more shales and clays and by its varied fossil fauna. A large part of the collections of Peterson, Douglass, Riggs, and others came from this horizon. Riggs[8] made sections and careful observations of this

[5] Peterson, O. A. in Osborn, H. F. Fossil Mammals of the Uinta Basin, Expedition of 1894. Bull. Am. Mus. Nat. Hist., Vol. VII, p. 72, 1895.

[6] Douglass, Earl. Geology of the Uinta Formation. Bull. G. S. A., Vol. 25, 1914.

[7] This is the lowest stratum in which we have found oreodont material.

[8] Riggs, Elmer S. New or Little Known Titanotheres from the Lower Uinta Formation. Field Museum of Natural History, Pub. 159, Vol. IV, No. 2, 1912.

horizon and the upper part of A, from the rim of White River north through the Coyote Basin.

Horizon C formerly included what is now called Duchesne River, but is now confined to the lower part (C^1 of Osborn).[9] In the central part of the Basin there is a sharp break lithologically between this horizon and the overlying Duchesne River, while in the eastern and western parts the transition is gradual, making it more difficult to establish a definite division. The lower part of Horizon C is chiefly composed of alternating bands of sandstones, shales and clays while nearer the top there are fewer sandstones and more shales and clays. These are friable and with the overlying more resisting sandstones of the basal Duchesne River, form a prominent southern escarpment which can be seen for several miles along the Randlett, Dry Gulch and lower Lake Fork areas.

GREEN RIVER FORMATION

The Green River Formation has been studied by D. E. Winchester,[10] E. G. Woodruff, D. R. Day,[11] and others. It is commonly referred to as the Green River Shales and occupies the greater part of the southern area of the Uinta Basin, resting on the Wasatch Formation to the south and underlying the Uinta Eocene Formation to the north. It is made up mostly of oil shales containing numerous fossil plants and insects. The Carnegie Museum field parties have collected various reptile, mammal, bird, and fish remains from this formation in the vicinity of Powder Springs near the Utah-Colorado line, about three miles south of U. S. Highway 40. Some of the bird bones have been described by Dr. Alexander Wetmore.[12]

[In Plate XLVI accompanying this article the following manuscript names appear: *Protictops alticuspidens*, *Mesagriochœrus primus*, *Leptomeryx ? minutus*, *Epitriplopus medius*, and *Hyracodon primus*. These names were applied to new forms by the late O. A. Peterson in descriptions which will appear in a following article. Likewise the names *Mytonlagus petersoni* (= *Mytonolagus petersoni* (in new spelling), *Leptotomus kayi* and *Protadjidaumo typus* are here used for the first time, and are manuscript names applied to new forms to be described by J. J. Burke in later articles. Editor's note.]

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[9] Osborn, H. F. Titanotheres of Ancient Wyoming, Dakota and Nebraska. U. S. Geol. Surv. Monograph, 55, 1929.

[10] Winchester, D. E. Oil Shale of the Uinta Basin, Northeastern Utah. U. S. G. S. Bull., 691 B, 1918.

[11] Woodruff, E. G. and Day, D. T. Oil Shale of Northwestern Colorado and Northeastern Utah, U. S. G. S. Bull., 581, pp. 1-20, 1914.

[12] Wetmore, Alexander. Fossil Birds from the Green River Deposits of Eastern Utah. Annals Carnegie Museum, Vol. XVI, pp. 391-402. April 1926.

LITHOLOGICAL CROSS-SECTION OF THE UINTA AND DUCHESNE RIVER FORMATIONS, DUCHESNE COUNTY, UTAH

Beginning on the south side of a prominent Butte, one-fourth mile south of U. S. Highway 40, approximately five hundred yards west of Strawberry River in T. 4S., R. 5W. U. S. M., then crossing the river to a prominent point north of the highway at Strawberry River Bridge, then west of north on the west side of Duchesne River, crossing the Duchesne River at the mouth of Rock Creek and up the east side of Rock Creek to the base of the Uinta Range.

	West section on map	Feet	Inches
	Top of section	3341	5
153.	Sandstone and shales[13] alternating; sandstones yellowish and brown; shales, red, brown, yellow and purplish	462	
152.	Sandstone, massive, brownish gray	18	6
151.	Sandstone and shale, alternating bands	15	
150.	Sandstone, massive, light brown	10	
149.	Sandstone and shale, alternating bands	21	9
148.	Sandstone, brownish gray	18	3
147.	Shale and sandstone, alternating	58	
146.	Sandstone, massive, ferruginous	49	
145.	Shale, sandy, purple	9	
144.	Sandstone, massive, conglomeratic	15	
143.	Shale, brownish red	2	6
142.	Sandstone	10	6
141.	Shale, very sandy	3	9
140	Sandstone, massive	14	9
139.	Sandstone, massive with a few bands of shale	43	
138.	Sandstone, shaly, dark red and brown	19	
137.	Sandstone, light brown	9	6
136.	Sandstone and shale, alternating, appearing on surface as being all shale, reddish brown	27	6
135.	Shale, red	17	6

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[13] There are several massive sandstones occurring in this series at the bases of which the shales are much thicker than the shales occurring in the usual alternating series; the sandstones predominate.

		Feet	Inches
134.	Sandstone, yellowish gray	31	
133.	Sandstone, massive, light brown	53	6
132.	Shale, sandy, reddish brown	21	
131.	Sandstone, light yellow	5	6
130.	Shale, red	4	3
129.	Sandstone, massive, brown	18	
128.	Shale and sandstone bands	10	6
127.	Sandstone, yellowish brown	4	6
126.	Shale, reddish brown	7	1
125.	Sandstone, light gray	16	6
124.	Shale, sandy, variegated	1	9
123.	Sandstone, with a small, soft band in center making it appear as two separate strata, yellowish	5	5
122.	Sandstone, massive, yellowish brown with small lenses of brownish shale	59	6
121.	Sandstone, light brown with small lenses of reddish brown shale	15	
120.	Shale, reddish brown	2	
119.	Sandstone, yellowish brown	11	
118.	Shale, very sandy, mottled	5	5
117.	Sandstone, yellowish brown	20	6
116.	Shale, sandy, reddish brown	17	6
115.	Sandstone, massive, light brown	22	
114.	Shale, very sandy, brown	6	10
113.	Sandstone, light brown	11	
112.	Shale and sandstone, alternating, brown; shale very sandy; appears to be all shale on the surface	15	3
111.	Sandstone, light brownish gray, checking into one to two-foot blocks	5	5
110.	Shale, brown	4	8
109.	Sandstone, shaly, reddish brown	2	4
108.	Sandstone, light brown and gray	17	6
107.	Sandstone and shale, alternating	19	4
106.	Sandstone, yellow	12	6
105.	Sandstone and shale, alternating bands	17	
104.	Sandstone, bands	30	6
103.	Sandstone and shale, alternating	18	6
102.	Sandstone, massive, gray	33	
101.	Sandstone and shale, alternating	11	
100.	Sandstone, massive, grayish brown	28	6
99.	Shale, reddish brown	5	6
98.	Sandstone, massive, light gray	28	
97.	Sandstone and shale, alternating	21	
96.	Sandstone, light gray	16	6
95.	Sandstone and shales, alternating	42	6
94.	Sandstone, light gray	2	

		Feet	Inches
93.	Shale, brown	5	
92.	Sandstone, massive, light brown. Base of Duchesne River formation	12	
91.	Sandstone and shale, alternating bands; sandstone mostly laminated	223	
90.	Sandstone, massive at base, laminated at top	34	6
89.	Sandstone and shale, alternating bands; sandstone gray; shale brown and blue	44	
88.	Sandstone with small shale lenses	12	
87.	Sandstone, laminated, greenish	10	6
86.	Shale, bluish gray	7	
85.	Sandstone, light gray	7	2
84.	Sandstone and shale, alternating bands; sandstone gray and shales brown	52	
83.	Sandstone, light gray	27	6
82.	Shale, brown	1	8
81.	Sandstone, light brown	5	
80.	Shale, reddish brown	11	
79.	Sandstone, brownish gray	9	
78.	Sandstone and shale, alternating; sandstone light gray; shale brown	40	
77.	Sandstone, light gray	12	8
76.	Shale, brown	10	
75.	Sandstone, light brown	15	
74.	Sandstone and shale, alternating; sandstone light gray, shale brown	13	
73.	Sandstone, light gray	19	
72.	Shale, reddish brown	13	
71.	Sandstone, light gray	7	5
70.	Shale, red	3	4
69.	Sandstone, light brown	8	
68.	Shale, reddish brown	13	6
67.	Shale and sandstone, alternating; shale red	30	
66.	Sandstone, massive, light brown	7	
65.	Sandstone and shale, alternating bands	11	
64.	Shale with lenses of sandstone; shale brownish	20	
63.	Sandstone, light gray	5	6
62.	Shale and sandstone, alternating; shale red	36	6
61.	Sandstone, massive	15	6
60.	Shale, reddish brown	11	4
59.	Sandstone, massive, gray	13	
58.	Sandstone and shale, alternating, shale red	24	
57.	Sandstone, light brown	33	
56.	Shale, sandy, brownish	16	6
55.	Sandstone, brownish gray	9	10
54.	Shale with layers of sandstone near base; shale red	11	2

		Feet	Inches
53.	Sandstone, light gray	5	7
52.	Shale and sandstone: shale reddish	1	7
51.	Sandstone, brown	3	
50.	Shale, sandy, reddish	3	2
49.	Sandstone, light gray	6	5
48.	Shale with thin sandstones; shale brown	10	10
47.	Sandstone, massive, light gray	19	
46.	Shale and sandstone, alternating bands; shale red	16	4
45.	Sandstone, massive, brownish gray	14	
44.	Shale, sandy, reddish	12	
43.	Sandstone, yellowish brown	11	6
42.	Sandstone and shale, alternating; sandstone light gray; shale brown	55	
41.	Shale, with sandstone lenses; shale light blue and brown	32	6
40.	Sandstone, shaly, showing mud-cracks	1	
39.	Shale, brown and gray-blue	17	4
38.	Shale and sandstone, alternating; shale red; sandstone brown	7	
37.	Sandstone, light brown	5	9
36.	Shale, bluish gray	77	
35.	Shale and sandstone, alternating, light colored	25	
34.	Sandstone, light brown	2	2
33.	Shale, slate color	9	6
32.	Shale and sandstone, alternating; shale bluish; sandstone light gray	73	
31.	Sandstone, brown	3	6
30.	Sandstone and shale, alternating	28	6
29.	Shale, brownish gray	34	
28.	Sandstone and shale, alternating	27	6
27.	Shale, sandy at base and top, variegated	143	
26.	Sandstone, massive, yellow	17	
25.	Sandstone and shale, alternating; shale reddish brown	9	
24.	Sandstone, massive, brown	14	6
23.	Shales, purple and brown	26	
22.	Sandstone, light gray	3	
21.	Shale, sandy	13	
20.	Sandstone, laminated	13	
19.	Sandstone	17	6
18.	Sandstone and shale, alternating	22	
17.	Sandstone, massive, light gray	16	3
16.	Sandstone, brown, ripple-marked	6	
15.	Shale, alkaline, bluish gray	4	6
14.	Limestone	3	
13.	Shale, dark gray	8	
12.	Sandstone, yellowish gray	2	
11.	Shale, reddish brown	1	6

		Feet	Inches
10.	Sandstone, heavy-bedded, gray with iron concretions	7	
9.	Shales, variegated	45	
8.	Sandstone, loosely-cemented, brownish gray	2	6
7.	Sandstone and shale alternating; sandstone weathering gray on surface; shale dark	20	
6.	Shale, green and purple	21	
5.	Sandstone, light gray	3	6
4.	Sandstone and shale alternating; shale reddish brown; sandstone laminated, light gray	15	
3.	Sandstone, shaly, light gray	2	6
2.	Shale, variegated[14]	3	6
1.	Sandstone, loosely cemented, yellow	10	
	Base of section.		

LITHOLOGICAL CROSS-SECTION OF THE UINTA AND DUCHESNE RIVER FORMATIONS, UINTA COUNTY, UTAH

Reprinted from Annals Carnegie Museum, Vol. XX, June 30, 1931, p. 301.

	East section on map.	Feet	Inches
	Top of section	3020	3
230.	Sandstone, conglomerate and brownish red clay; the clays are mostly sandy	91	
229.	Clay, brownish red and variegated with lenses of sandstone	93	
228.	Sandstone, reddish gray and light brown	23	
227.	Conglomerate	4	
226.	Fossiliferous conglomerate and sandstone, fine grained, alternately soft and hard (Carnegie Titanothere Quarry)	3	
225.	Clay, sandy, variegated	16	
224.	Conglomerate and coarse sandstone	7	
223.	Sandstone and brownish red clay	38	
222.	Sandstone, coarse, light gray	3	
221.	Clay, reddish brown	22	
220.	Sandstone, coarse, brownish and gray	14	
219.	Clay, bluish white	22	
218.	Sandstone and clay, light brownish red	49	
217.	Clay, brownish red	8	
216.	Sandstone, coarse, gray	16	

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[14] Carbonaceous shale, about three inches thick, occurs about the middle of this shale.

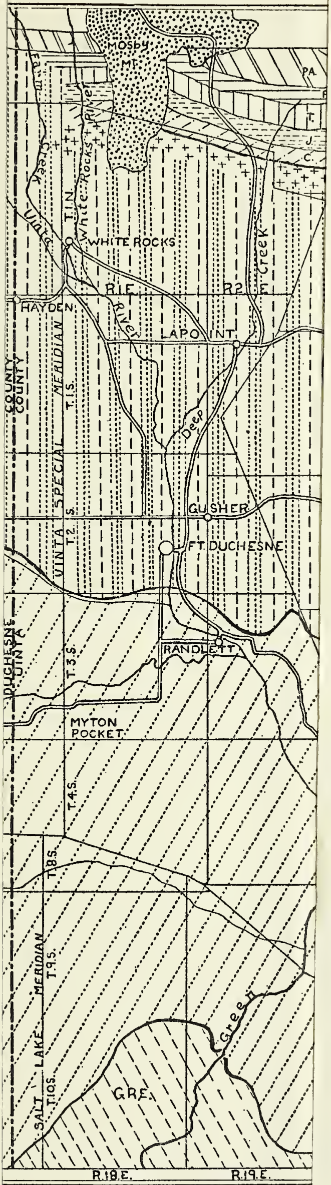
		Feet	Inches
215.	Sandstone and clay, reddish brown	19	
214.	Sandstone, nodular	5	
213.	Sandstone, soft, light gray	2	
212.	Shale, variegated with lenses of laminated sandstone	25	
211.	Shale, reddish brown	7	
210.	Sandstone, coarse, gray	16	
209.	Clay, yellow, brown and red, with lenses of nodular sandstone	26	
208.	Sandstone, light gray	20	
207.	Shale, brownish red, with lenses of nodular sandstone	15	
206.	Sandstone, coarse, with lenses of brownish red clay	33	
205.	Shale, sandy, brownish red	12	
204.	Shale, sandy, brownish red with lenses of gray sandstone	26	
203.	Sandstone, light gray	5	
202.	Conglomerate	4	
201.	Sandstone and reddish brown sandy shale	23	
200.	Conglomerate	6	
199.	Shale, alternating brownish red and purple, with thin lenses of sandstone	41	
198.	Sandstone, soft, light gray	2	
197.	Clay, brownish red and blue-white	14	
196.	Sandstone, light gray	8	
195.	Sandstone and shale, variegated	9	
194.	Sandstone, laminated	10	
193.	Clay, brownish red and blue-gray	47	
192.	Conglomerate	10	
191.	Sandstone and shale, alternating strata, shale brownish red	30	
190.	Sandstone, with two small strata of red shale	37	
189.	Sandstone and shale, alternating	42	
188.	Sandstone, light colored	11	
187.	Clay, brownish red, and purple	16	
186.	Sandstone, nodular, light gray	38	
185.	Sandstone, soft, light colored	26	
184.	Sandstone and reddish clay, alternating	8	
183.	Sandstone, light gray	12	
182.	Clay, red	30	
181.	Sandstone, massive, light gray	28	
180.	Sandstone and variegated clays alternating	62	
179.	Clay, brown, red and blue-gray	2	6
178.	Sandstone and clay, alternating	20	
177.	Sandstone, yellowish gray	9	
176.	Sandstone and shale, brownish red	10	
175.	Sandstone, nodular	7	
174.	Clay, brownish red	6	
173.	Sandstone, light gray, weathering into irregular blocks on surface	2	

		Feet	Inches
172.	Clay, brownish red	8	
171.	Sandstone, coarse, heavy bedded	8	
170.	Clay, red, capped by green band	20	
169.	Sandstone, coarse, yellowish	15	
168.	Sandstone and shale, alternating bands	20	
167.	Sandstone, coarse, light gray	11	
166.	Clay, reddish brown	3	
165.	Sandstone, fine grained, gray	2	
164.	Shale, brownish red	5	
163.	Sandstone, coarse	3	
162.	Clay, brownish red	2	6
161.	Sandstone, light gray	1	6
160.	Clay, brownish red	5	
159.	Sandstone, light gray	2	
158.	Clay, sandy, brownish red	5	
157.	Sandstone, fine grained, bluish white	4	
156.	Clays, variegated, small lenses of sandstone	17	
155.	Sandstone, light gray	4	
154.	Clay, variegated	3	
153.	Shale, variegated, capped by 18 inches of sandstone	6	
152.	Sandstone, coarse, light gray, weathers dark on surface	4	
151.	Shale, reddish brown	16	
150.	Sandstone	3	
149.	Shale, variegated	9	
148.	Sandstone, soft	2	
147.	Shale, sandy, purple, blue and red	8	
146.	Sandstone, nodular, gray	4	
145.	Shale, sandy, brown, red and blue-white, with lenses of sandstone	18	
144.	Sandstone, light gray	4	
143.	Shale, reddish brown and blue	5	
142.	Sandstone, light gray	4	
141.	Clay, dark reddish brown	10	
140.	Sandstone, very loosely cemented, bluish white, appears on surface as sandy shale	16	
139.	Sandstone, yellowish gray	12	
138.	Clay, brownish red	26	
137.	Sandstone, yellowish	10	
136.	Shale, sandy, blue and yellowish	20	
135.	Shale, sandy, light gray	5	
134.	Shale, reddish brown	4	
133.	Sandstone, coarse, light gray	3	
132.	Shale, variegated	10	
131.	Sandstone, coarse, loosely cemented	16	
130.	Shale, reddish green, and purple	40	
129.	Sandstone, coarse, light gray	5	

		Feet	Inches
128.	Shale, red, gray, and purple	40	
127.	Sandstone	5	
126.	Sandstone and shale, alternating bands, shales variegated.	12	
125.	Sandstone, yellow and gray	10	
124.	Shale, reddish brown, with lenses of sandstone	26	
123.	Sandstone, fine grained, gray	3	
122.	Sandstone, with lenses of shale	15	
121.	Sandstone, gray	4	
120.	Shale, dark reddish brown	6	
119.	Sandstone	5	
118.	Shale, sandy, variegated	6	
117.	Sandstone, gray, weathering brown on surface	14	
116.	Shale and nodular sandstone, reddish brown	30	
115.	Sandstone and shale, alternating bands	26	
114.	Sandstone, coarse, light gray	3	
113.	Shale, reddish and blue, with two small bands of nodular sandstone	15	
112.	Sandstone, light gray weathering dark on surface	4	
111.	Shale, reddish and yellow	22	
110.	Sandstone, blue-white	6	
109.	Shale, variegated	15	
108.	Sandstone, nodular, light colored	5	
107.	Shale, variegated	12	
106.	Sandstone, nodular, gray	8	
105.	Clay, bluish gray, with two small bands of nodular sandstone	26	
104.	Shale, sandy, reddish brown	23	
103.	Sandstone, coarse	6	
102.	Clay, reddish and white	15	
101.	Sandstone, coarse, light colored	6	
100.	Shale, variegated, reddish, green and brown	65	
99.	Sandstone, nodular, light colored	6	
98.	Shale, variegated	14	
97.	Sandstone, nodular, gray	8	
96.	Shale, and sandstone, alternating bands brown and blue-white	80	
95.	Shale, variegated	36	
94.	Sandstone, nodular, light gray	2	
93.	Shale, reddish brown	4	
92.	Shale, blue	1	
91.	Shale, sandy, brownish	4	
90.	Sandstone, nodular, light gray	4	
89.	Shale, purple, gray and green	12	
88.	Sandstone, nodular, gray	1	
87.	Shale, gray and reddish	5	
86.	Shale, sandy, brown and gray	12	

		Feet	Inches
85.	Sandstone, soft, light gray	2	
84.	Shale, reddish brown and green	17	
83.	Sandstone, nodular, gray	6	
82.	Shale, reddish gray and green	12	
81.	Shale, reddish brown	15	
80.	Sandstone, nodular, light gray	4	
79.	Shale, variegated	16	
78.	Sandstone, hard, gray	5	
77.	Shale, with sandstone nodules, reddish, purple and green	8	
76.	Sandstone, very hard, nodular	1	3
75.	Sandstone, coarse, gray	8	
74.	Shale, red, green and purple	7	
73.	Sandstone, gray	3	
72.	Shale, red and green	5	
71.	Sandstone, fine grained, gray	4	
70.	Shale, sandy, variegated with sandstone nodules	3	
69.	Sandstone, fine grained, weathering brown on surface	3	
68.	Sandstone, fine grained nodules	1	
67.	Shale, variegated	7	
66.	Sandstone, gray	22	
65.	Shale, sandy, reddish and green with sandstone nodules	14	
64.	Shale, sandy, greenish	6	
63.	Sandstone, nodular, gray	3	
62.	Clay, greenish	4	
61.	Sandstone, light gray	5	
60.	Shale, sandy	2	
59.	Sandstone, gray	13	
58.	Shale, sandy, greenish	3	
57.	Sandstone, gray	3	
56.	Shale, greenish gray	5	
55.	Sandstone, heavy, gray	6	
54.	Shale, green and gray	7	
53.	Sandstone, fine grained	5	
52.	Shale, red, green and purple	15	
51.	Sandstone, light gray	8	
50.	Shale, variegated, with sandstone nodules	14	
49.	Sandstone, light gray	6	
48.	Shale, variegated, green and brown	10	
47.	Sandstone, fine grained, gray	2	
46.	Shale, greenish	5	
45.	Sandstone, dark gray, weathering into blocks on the surface	2	
44.	Shale, green	5	
43.	Sandstone, light gray	2	
42.	Shale, sandy, brownish and green	10	6
41.	Sandstone, reddish brown	3	

		Feet	Inches
40.	Shale, sandy, greenish and brown	5	
39.	Sandstone, coarse, light gray	10	
38.	Shale, gray	10	
37.	Sandstone, hard, gray	1	6
36.	Shale, sandy, gray	17	
35.	Shale, sandy, green	7	6
34.	Sandstone, hard, brown	6	
33.	Clay, brownish red	4	
32.	Sandstone, partly laminated, upper part copper stained	20	
31.	Clay, green		6
30.	Sandstone, greenish gray	36	
29.	Sandstone, blue-gray	6	
28.	Sandstone, coarse, gray, weathers into greenish gray on surface	18	
27.	Sandstone, fine grained, reddish brown, weathers into blocks	4	
26.	Clay, sandy	6	
25.	Shale, sandy, gray	4	
24.	Sandstone, coarse, yellow	12	
23.	Shale, greenish	12	
22.	Sandstone, reddish brown	21	
21.	Sandstone, greenish yellow	17	
20.	Shale, sandy, blue	22	
19.	Sandstone, brownish gray	13	
18.	Sandstone, coarse, streaked with greenish bands	16	6
17.	Clay, light blue	3	
16.	Shale, sandy, brownish red	13	
15.	Sandstone, very hard, brownish gray	6	
14.	Shale, sandy, brown	10	
13.	Clay, bluish white	10	
12.	Shale, sandy, reddish	7	
11.	Sandstone, coarse, gray	11	
10.	Shale, sandy, greenish yellow	4	
9.	Sandstone, coarse, with blue clay nodules	6	
8.	Shale, sandy, blue-gray	6	
7.	Clay, brownish	4	6
6.	Sandstone, gray	6	
5.	Sandstone, greenish	3	6
4.	Clay, reddish brown	7	
3.	Sandstone, greenish gray	4	
2.	Sandstone and shale, alternating bands reddish brown on surface	111	
1.	Sandstone, heavily bedded	20	
	Base of section.		


Mosby Mt.
PA.
T.
J.
C.
Farm Creek
White Rocks River
Uinta
T.1.N.
WHITE ROCKS
R.1.E.
R.2.E.
Creek
HAYDEN
River
LAPOINT
COUNTY
COUNTY
UINTA SPECIAL MERIDIAN
T.1.S.
Deep
T.2.S.
GUSHER
FT. DUCHESNE
DUCHESNE
UINTA
T.3.S.
RANDLETT
MYTON
POCKET
T.4.S.
T.8.S.
T.9.S.
T.10.S.
SALT LAKE MERIDIAN
Green
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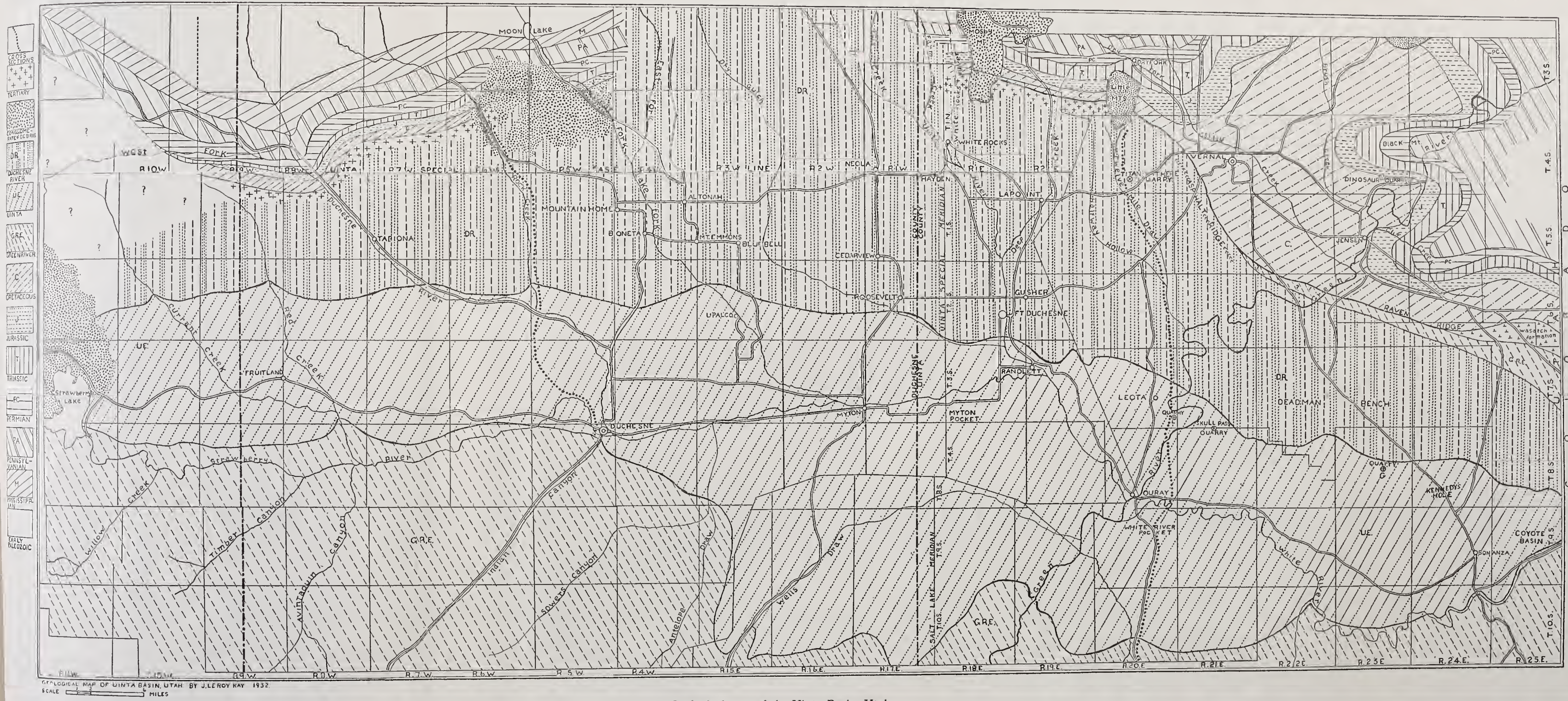
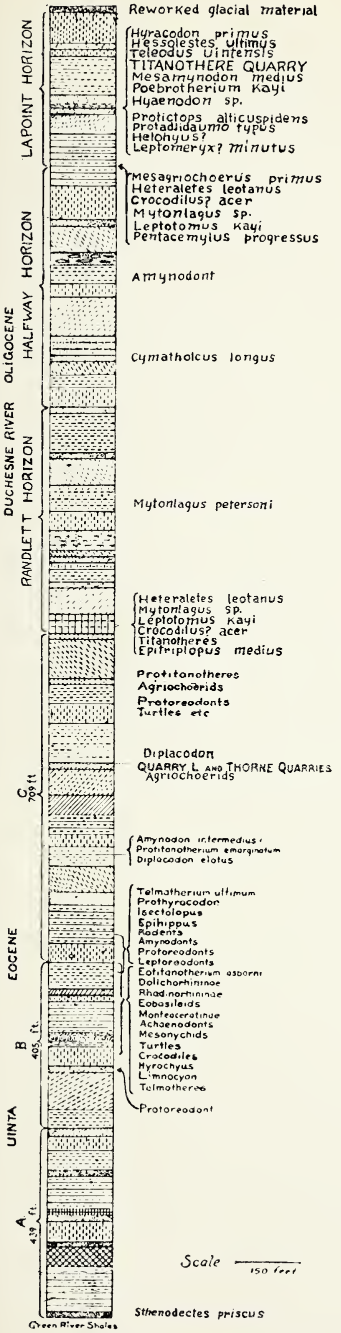
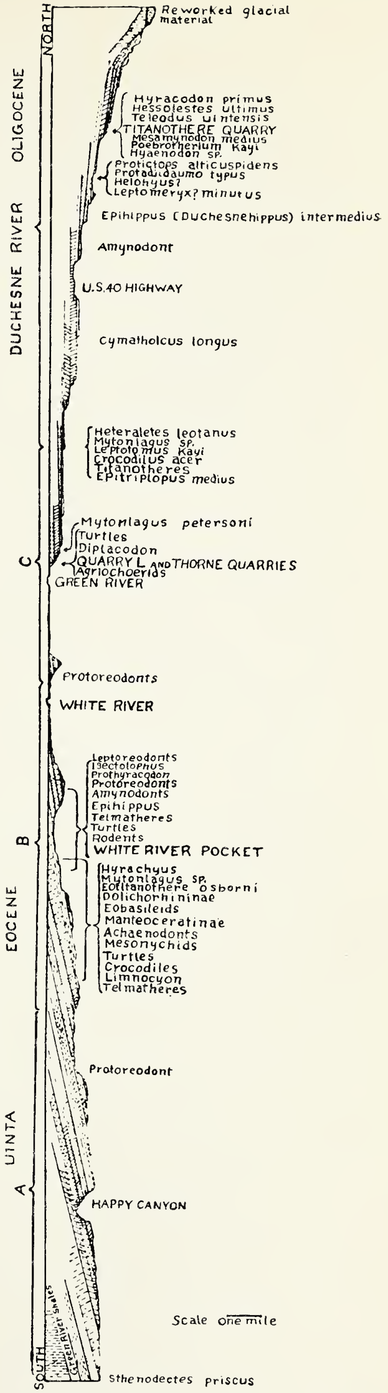
R.18.E.
R.19.E.



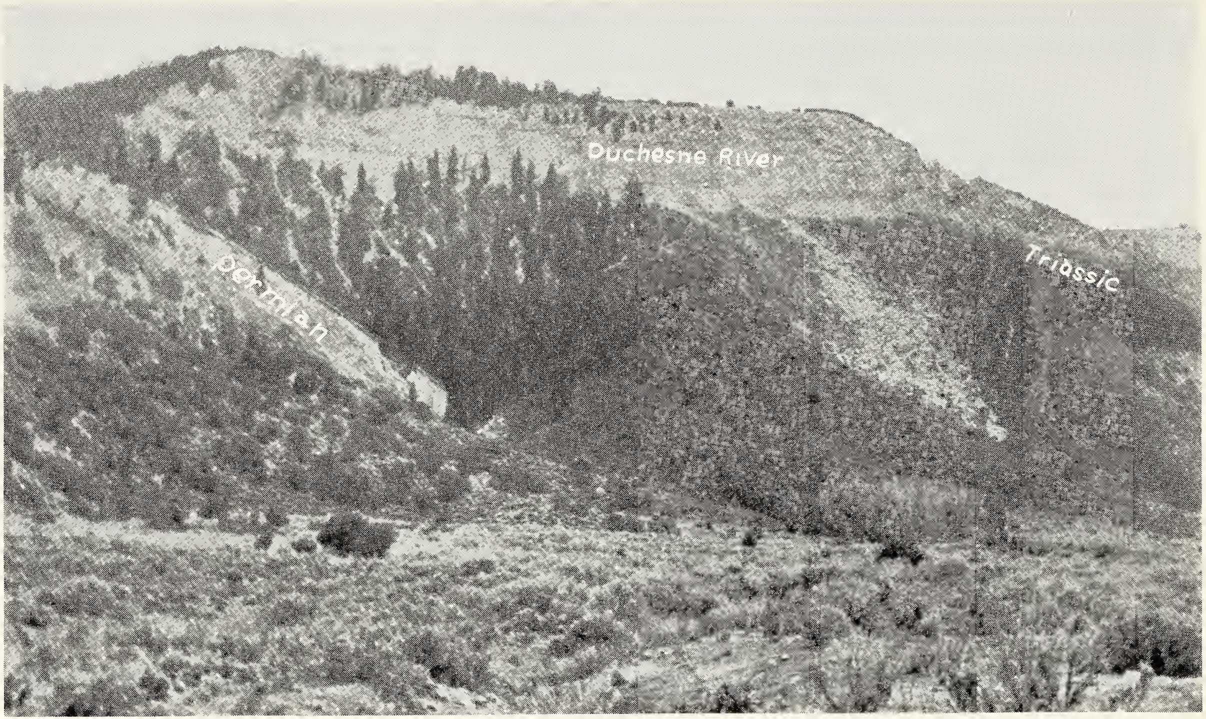
Geological map of the Uinta Basin, Utah.



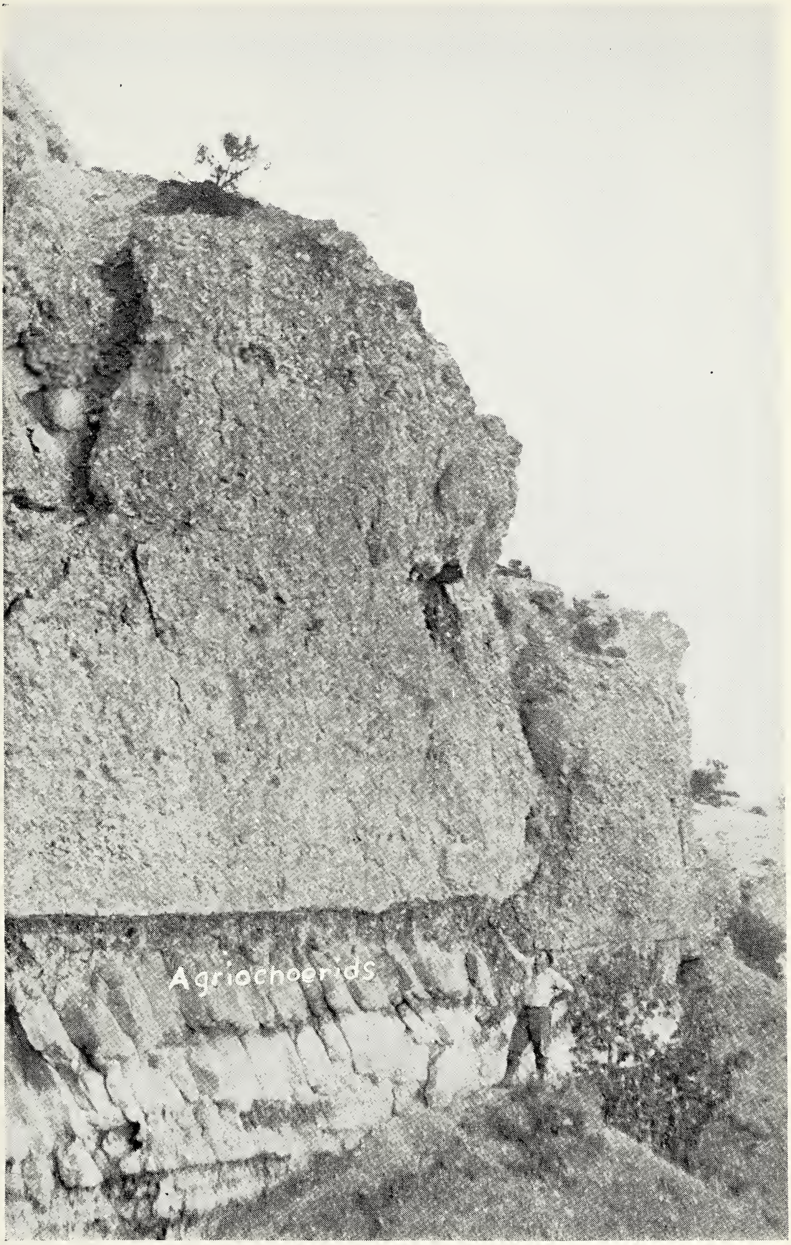
Columnar section of Horizons A. B. C. and Duchesne River Oligocene.



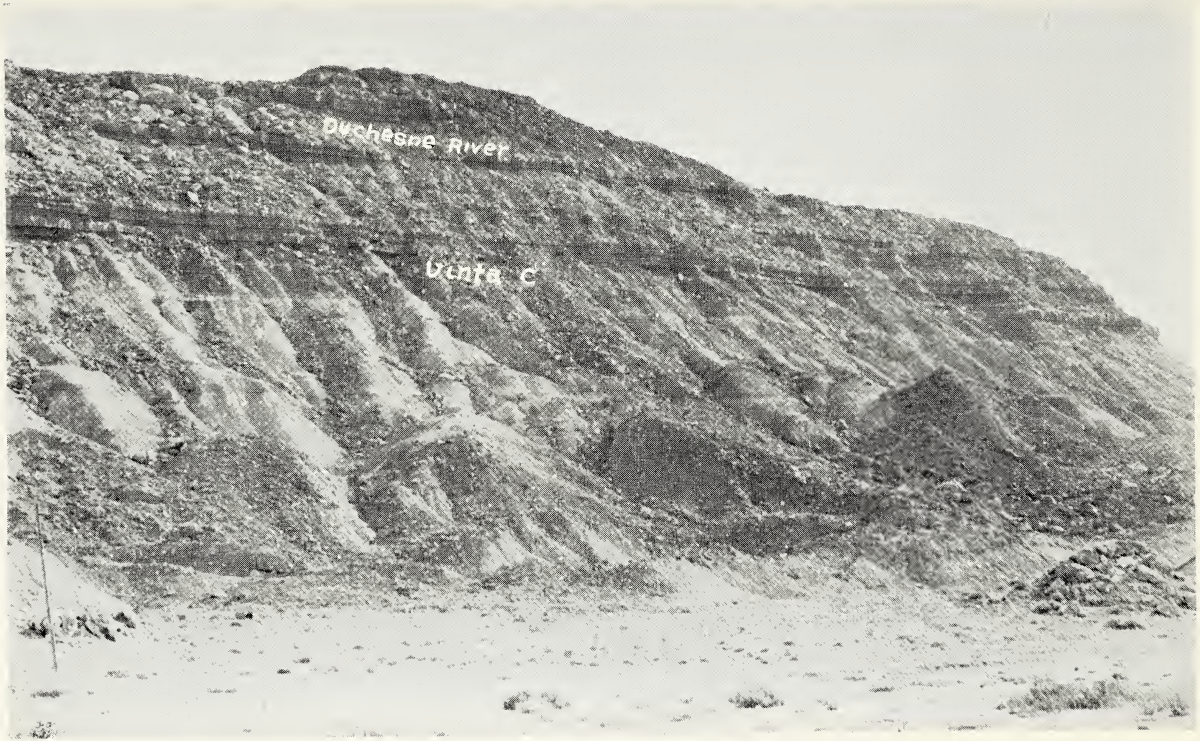
Stratigraphic section of Uinta Basin.



Conglomerates of the Duchesne River Formation. Resting horizontally on the steeply dipping Triassic and Jurassic sediments at Lake Fork. T. 2N. R., 5W. U. S. M. Photo by R. L. Fricke.



Conglomerate of the Duchesne River Formation at
Asphalt Ridge T. 5S., R. 21E. S. L. M.



Duchesne River sandstones resting on variegated clays of Uinta C. Randlett Point.
T. 3S., R. 21E. U. S. M. Photo by R. L. Fricke.

VII. LIST OF SPECIES AND DESCRIPTION OF NEW MATERIAL FROM THE DUCHESNE RIVER OLIGOCENE, UINTA BASIN, UTAH.

By O. A. Peterson*

The mammalian fossil fauna indicated in the following list appears, on the whole, to present a transition, remarkably well along in its modernization, from the Upper Eocene to the lower Oligocene of other localities in America. While there is present in this horizon the evidence of archaic carnivorous mammals (*Hessolestes*), the progress in the development toward the more modernized lower Oligocene mammalia of this new fauna, as now known, is well marked. In comparing the age of the Duchesne River Oligocene with the European Tertiary horizons, it agrees best perhaps with the lignite deposits of France and Italy. Scott[1] has already placed this new American horizon with the Cadibona (Ligurian) series of Italy.

LIST OF SPECIES

REPTILIA

Testudinata

Cymatholcus longus Clark

Crocodilia

Crocodilus (*?*) *acer* Cope

MAMMALIA

Insectivora

Protictops alticuspidens Peterson, gen. et sp. nov.

Carnivora

Hessolestes ultimus Peterson
Hyænodon sp.

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*Mr. Peterson's lamented death occurred on November 12, 1933. He had no opportunity to read the proof of this paper. Editor's Note.

[1] "An Introduction to Geology," William Berryman Scott, (Third Edition), Vol. II, 1932, p. 312.

Issued Nov. 19, 1934.

RODENTIA**

Leptotomus kayi Burke
Protadjidaumo typus Burke
Mytonolagus sp.

ARTIODACTYLA

Helohyus (*?*)
Pentacemylus progressus Peterson
Mesagriochœrus primus Peterson, gen. et sp. nov.
Diplobunops (?)
Ticholeptus?[2]
Poabromylus kayi Peterson
Leptomeryx minutus Peterson, sp. nov.

PERISSODACTYLA

Epihippus (*Duchesnehippus*) *intermedius* Peterson
Teleodus uintensis Peterson
Heteraletes leotanus Peterson
Epitriplopus medius Peterson, sp. nov.
Hyracodon primus Peterson, sp. nov.
Mesamynodon medius Peterson
Chalicothere?

DESCRIPTION OF NEW MATERIAL

Order **INSECTIVORA**

Family LEPTICTIDÆ

Protictops alticuspidens gen. et sp. nov.

Holotype: Fragment of lower jaw with M_{1-2}, roots of P_4 and M_3. Carnegie Museum No. 11917.

Horizon: Duchesne River Oligocene, Lapoint Horizon.[3]

Locality: Fourteen miles west of Vernal, Utah.

Principal characters of the holotype. Trigonid relatively large and the heel small when compared with the molars of *Ictops acutidens*

**The new genera and species listed under *Rodentia* will be treated in later papers by J. J. Burke. Editor's Note.

[2] A fragment of a lower jaw, with P_4 and M_1, doubtfully referred to *Ticholeptus*, in Mem. Car. Mus., Vol. XI, 1928, p. 99, and supposed to have been found in a later horizon of the Uinta Tertiary by Mr. Wm. Haslem was perhaps not found in the Uinta Basin at all.

[3] In the same horizon in which the Titanothere Quarry, 11 miles west of Vernal, is located.

Douglass. The paraconid is larger and of greater functional value when compared with the latter species. In the present form, the heel of the molar is of a more nearly cross-crest structure but with the median region constricted and the median tubercle very indistinct or not at all indicated, while in *Ictops acutidens* the median tubercle is well formed. The specimen pertains to an animal approximately one-half the size of *Ictops acutidens.*

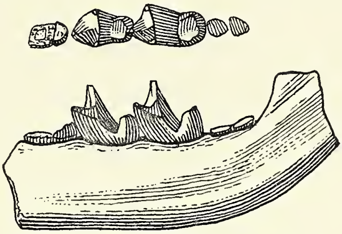

FIG. 1. *Protictops alticuspidens* Peterson, gen. et sp. nov., holotype C. M. No. 11917, M_1, M_2 and roots of P_4 and M_3 right, occlusal view, and portion of right mandibular ramus, internal view. X 4.

An upper premolar (?P^3) found in the same horizon and locality in which *Protictops* was found, is associated with this series of specimens and referred to the Insectivora. It is rather doubtful that the specimen pertains to the genus proposed above, because the posterior part of the prominent protocone is more nearly of a carnassial structure and has no true tritocone as in *Ictops*. There is, however, an antero-external basal tubercle as in P^3 of *Ictops*. The deuterocone is definitely formed, but basal in position and the crown is surrounded by prominent external, internal and posterior cingula.

Order **ARTIODACTYLA**

Family HELOHYIDÆ Marsh[4]

Helohyus (?) sp.

A fragment of a lower jaw, No. 11912, with P_4 and M_1 in position found well up in the Duchesne River Oligocene (Lapoint Horizon) is of considerable interest. The specimen represents a *Lophiohyus* or *Helohyus* type but is in size more nearly equal to that of *Helohyus* *lentus* Marsh which Sinclair[5] thinks is questionably referred to the genus *Helohyus*.

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[4] There is much uncertainty regarding the systematic position of these early bunodont artiodactyls with simple lower premolars, in America. *Wasatchia* from the Big Horn Wasatch and *Lophiohyus* as well as *Helohyus* from the Bridger appear to me as of rather close relationship but I am not at present reconciled in placing *Gobiohyus orientalis* Matthew and Granger in this family, due chiefly to the advanced condition of the premolar teeth in the lower jaw of the Asiatic genus. See Amer. Mus. Novitates, No. 198, Nov. 21, 1925, p. 7.

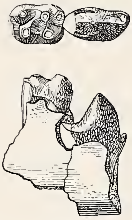

Fig. 2. (?) *Helohyus* sp., C. M. No. 11912, P_4-M_1 right, occlusal view, and external view of fragment of right mandibular ramus. × ½.

The P_4 of this specimen apparently agrees in general with the characters of *Helohyus* given by Sinclair. Thus the protoconid is high, subtrenchant with anterior and posterior vertical ridges indicated; prominent posterior cingulum-like heel and a minute antero-internal cuspule. From the posterior heel, forward to the middle of the base of the protoconid, there are well indicated cingula both external and internal; no deuteroconid. M_1 has the paraconid present which is characteristic of the genus *Helohyus*.[6] In this specimen the posterior portion of M_1 is, however, very little, if any, wider than the trigonid. From the base of the proto- and metaconids there are low but discernible ridges which extend backward, connecting with the base of the hypoconid, thus forming a shallow, triangular-shaped pit in the median valley of the crown. Anteriorly there is a rather delicately developed cingulum, while posteriorly the cingulum is ledge-like.

That this fragmentary specimen pertains to a distinct genus is entirely probable, but I refrain from using it as a type.

Measurements

Antero-posterior diameter of P_4 at the base of the crown	16 mm.
Transverse diameter of P_4 at the base of the crown opposite protoconid	9 mm.
Antero-posterior diameter of M_1 at the base of the crown	13 mm.
Transverse diameter of M_1 near posterior face	9 mm.
Transverse diameter of M_1 anteriorly	9 mm.

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[5] Bull. Amer. Mus. Nat. Hist., Vol. XXXIII, 1914, p. 283.

[6] While P_4 may easily pass as that tooth of an entelodont (*Archæotherium*), the presence of the paraconid prevents the association of this specimen with that group.

Family AGRIOCHŒRIDÆ

In the collection gathered by the Carnegie Museum field party during the season of 1932 there is no material of greater interest and importance than the fragmentary specimens of agriochœrids described below. Unfortunately the feet are not represented. From the mutilated skulls and jaws, as well as limb bones, few important characters are obtained, but the detailed structure of the dentition affords nearly everything desired in the way of forms in the line to the agriochœrids of the White River, John Day and other Oligocene deposits, while *Diplobunops* from the Uinta (Horizon C) previously described apparently represents a sub-family. The robustness of the premolar teeth, especially those anterior, in the latter genus, is well marked when compared with those teeth in the new material noted in the following discussion. The step towards the molarization of $P\frac{4}{4}$ in the new material is clearly an advance beyond *Protagriochœrus*, and it is certainly a great advance upon that in *Diplobunops* when the similarities in the appendicular structure in the latter genus and *Agriochœrus* are considered. In other words, the appendicular structure in *Diplobunops* from the Uinta C was fully advanced along the lines of *Agriochœrus* from the later Oligocene, while the cheek-teeth were far from having developed in equal ratio.

Mesagriochœrus primus gen. et sp. nov.

Holotype: Greater portion of skull and lower jaws, found in articulation; fragment of lumbar vertebra; greater part of radius and ulna; fragments of pelvis and other limb bones, Carnegie Museum No. 11893.

Horizon: Duchesne River Oligocene, near base, Randlett Horizon.

Locality: Two miles east and north of Randlett Point, Uinta County, Utah.

Principal characters: $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$; P^1 two-rooted and crown laterally compressed; P^2 similar to P^1, but with posterior portion of crown of greater transverse diameter; P^3 with a distinct deuterocone, placed well back, as well as a slight cingulum on the posterior face; P^4 with the apex of the protocone twinned and the initial step taken toward the postero-internal crescent; M^1 and M^2 with weak protoconule, while M^3 has little or no indication of such. P_1 with high, trenchant, and caniniform crown characteristic of the group; $P_{2\text{-}3}$ with laterally compressed and simple crowns; P_4 with well-developed deuteroconid, broad heel and the antero-internal body of the crown well-indicated. Lower molars relatively long and narrow. Limb bones slender when compared with those of *Diplobunops*. In size the animals range between that of *Protoreodon medius* and *P. parvus*.

The premaxillary is of fair proportionate size and in its alveolar border are inserted the roots of three incisors of nearly subequal size. The muzzle and facial region when compared with that of *Protoreodon*, may be considered as medium long. There is a short diastema between canine and P^1 as in *Protagriochœrus*. The malar of the material under study perhaps suggests most nearly that of *Protagriochœus*; it has not the abrupt lateral expansion seen in *Agriochœrus*, but the postorbital process is proportionally as robust, as is also the postorbital process of the frontal. The rather small and round orbit is, however, widely open posteriorly as in *Protagriochœrus* and later forms. The height of the alveolar border of the maxillary is relatively equal to that in *Agriochœrus*, and the infraorbital foramen appears to be similarly located (above P^3).

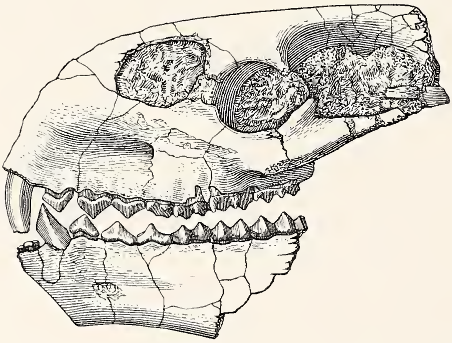

FIG. 3. *Mesagriochœrus primus* Peterson, gen. et sp. nov., holotype C. M. No. 11893. Skull and lower jaw from the left side. × ½.

As already stated there are three incisors of approximately subequal size. The canine is well proportioned and of the characteristically D-shaped cross-section. P^1, following the canine after a short diastema, has a simple crown, secant, laterally compressed, with an antero-posterior diameter somewhat less than in *Protagriochœrus*, but relatively greater than that in *Agriochœrus* in which P^1 is much reduced. The crown of P^2 is equally as sharp-pointed as that of P^1, but it is of somewhat greater transverse diameter and has a prominent basal cingulum on the postero-internal angle, but not what can be regarded as a deuterocone. P^3 has a deuterocone fairly well defined, a weak antero-internal cingulum, and the indication of a vertical rib at the posterior part on the internal face of the protocone like the corresponding one in *Agriochœrus* which is, however, of greater prominence in the genus of the White River Oligocene. The latter genus also has the cingulum more strongly developed on the posterior face of P^3 and therefore the initiative step towards the development of a tetartocone or posterior inner crescent is more clearly before us. The most interesting and extraordinary feature of the genus here proposed is the stage in the development of P^4. The two distinct vertical ribs or styles on the internal face of the protocone of P^4 in *Protagriochœrus*,[7] heretofore overlooked by students, have in the present genus advanced further. In the unworn tooth the apex of the protocone has reached the twinning stage, somewhat analogous to what we find in the molars of *Deltatheroides* and *Zalamdalestes* from the Mongolian Cretaceous described by Gregory and Simpson,[8] and referred to in later work by Gregory and Matthew. This structure of P^4 in our present specimen is so plainly evident that there can be no question as to the subsequent division of this tubercle into the proto- and tritocone, a step still further advanced in *Agriochœrus minimus* Douglass from the Thompson Creek Oligocene of Montana, and completely effected in the agriochœrids of the White River Oligocene of Dakota. On the posterior horn of the deuterocone crescent of P^4 in our new material there is a distinct vertical style which cannot be regarded as anything but the initial rudiment of the postero-internal crescent again slightly advanced in *Agriochœrus minimus* and which though small, is completely developed in the White River forms. The antero-external style of P^4 in the present genus is of greater prominence than that in the White River representatives and suggests more closely that in *Agriochœrus minimus.*

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[7] In the material referred to *Protoreodon* in the Carnegie Museum, the matured specimens usually show traces of the vertical styles on the inner face of the protocone on P^4 and the apex of the protocone has sustained more or less wear. The type of *Protoreodon parvus* as illustrated by Scott (Trans. Amer. Philos. Soc., N. S., Vol. XVI, 1889, Pl. VII, fig. 1a) indicates vertical ridges on the inner face of the protocone on P^4 and the apex of the protocone slightly twinned.

[8] Amer. Mus. Novitates, 1926, No. 22, p. 11 (*Deltatheroides*); p. 14, (*Zalamdalestes*).

ADDITION, SUBTRACTION, AND DIVISION OF THE MAMMALIAN DENTAL CUSPS

This process of division and addition of cusps on the fourth premolar in the agriochœrids is of noteworthy interest in connection with the origin of the cusps on the cheek dentition of the Mammalia, so much discussed by many anatomists in the recent past and ably reviewed in Osborn's work on the "Evolution of Mammalian Molar Teeth" (The Macmillan Company, New York, 1907). In some of the *Condylarthra*, Scott has shown that the tritocone may be seen in all stages from its incipiency to a fully developed tubercle. From Osborn's studies of the *Proboscidea* we learn that the basal cingula of the teeth developed into talons, talonids and multiple crests, while in the agriochœrids among the *Artiodactyla* there is apparently an extraordinary demand upon the function of a P^4 which had already, in the upper Eocene, reached the normal development usually found in the selenodont *Artiodactyla*. From the upper Eocene to the White River and John Day Oligocene we now see that this tooth yielded to form a molariform premolar unique in the suborder *Artiodactyla*. The succession of the deuterocone and tetartocone of the premolars in these agriochœrids apparently agrees with Scott's studies,[9] while the tritocone was a direct result from the process of division of the protocone. The latter tubercle on P^4 thus splits in two, forming subequal proto- and tritocones. This process of splitting is somewhat analogous to that in the deuterocone ridge, forming the deutero- and tetartocone in some *Perissodactyla* (*e.g.* Titanotheres), but perhaps more nearly analogous to the process in the molar dentition of *Deltatheroides* referred to above. Postero-internally the crescentic tetartocone in *Agriochœrus* is, in *Mesagriochœrus*, clearly an indication of a gradual development from the cingulum, which is more in line with some of the earlier conceptions of the origin of mammalian dental cusps.

Did the external tubercles of the upper molars in the ancestral agriochœrids and other selenodont artiodactyls divide from a primary tubercle similar to that indicated in P^4 of the protoreodonts, including *Protagriochœrus* and *Mesagriochœrus*? Professor William K. Gregory, in a recent publication (Science, Jan. 13, 1933, Vol. 77, No. 1985, p. 7) definitely states that the Cretaceous insectivorous placentals of Mongolia "show an ideally primitive stage in tri-tubercular upper molars and give long-looked-for paleontological proof that the primitive cusp was not on the inner side, as believed by Cope and Osborn, but was located on the main cusp, homologous with the main tip of the premolars.''

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[9] Proc. Acad. Nat. Sci. Philadelphia, Vol. 44, 1892, pp. 405-444.

Not only in *Agriochœrus*, but also in the oreodonts and other selenodont artiodactyls,[10] it is certain that the postero-internal crescent is similarly constructed to that in P^4 of *Agriochœrus*. Thus the anterior horn of the posterior crescent cuts off the posterior horn of the anterior crescent and continues outward well beyond the median longitudinal valley.

As above stated, the protoconules of M^1 and M^2 are reduced and that of M^3 slightly indicated or entirely absent. The para- and mesostyles in our specimen are reduced in size and the cingulum between them less firmly connected when compared with *Protagriochœrus* and *Diplobunops* from the upper Eocene, but the styles have not yet reached the sessile position and are not as gently rounded in shape as those in *Agriochœrus*; nor does the cross-valley between para- and metacone extend as far outward as in the latter genus, especially on M^1 and M^2. The lingual faces of the internal tubercles are also more sharply rounded than in *Agriochœrus*.

The ramus of the lower jaw is deep, thin, and the symphysis is long and robust. The second and third lower incisors, with slightly expanded crowns, are yet adhering to the front of the lower jaws and the median tooth was undoubtedly present. Though incisiform, the lower canine is slightly larger than the true incisors. P_1 has the characteristically high, sharply pointed, and laterally compressed crown. There is a very slight diastema between the first and second premolars. P_2 is of relatively greater antero-posterior extent when compared with that of *Agriochœrus* and is also more compressed laterally. P_3 is much like P_2, except that it has a greater transverse diameter posteriorly. The primary tubercle, (protoconid of P_4) is well-developed and rises well above the rest of the crown; the metaconid though low, is distinctly formed, while the apex of the deuteroconid cannot be said to be entirely isolated from the internal face of the protoconid as is the case in *Agriochœrus*. The anterior crest of the protoconid appears to be

[10] Wortman has pointed out (Bull. Amer. Mus. Nat. Hist., Vol. X, 1898, p. 101) that the metaconule has taken the place of the hypocone of M^3 in *Bunomeryx* among the Homacodonts, thus apparently subtracting a functional tubercle of this tooth in earlier forms of this line.

almost as far along in its development as it is in *Agriochœrus*, while postero-internally there is yet no indication of a tubercle; in *Agriochœrus*, on the other hand, P_4 is completely molariform, plus the anterior crest of the tritoconid which was already developed before the quadritubercular structure of the tooth took place.

The lower molars are relatively long and narrow when compared with those in *Agriochœrus*. The basal styles on the lingual face of the molars, though already indicated, are not as well developed as in the genus from the White River Oligocene. The heel of M_3 is of an equal proportionate length, but narrower than that in *Agriochœrus*.

A dorsal vertebra, well back in that series, is indicated by a portion of a centrum, the arch and the neural spine. The latter is thin, like the spines of the lumbars, but tapers rapidly towards the top; the prezygapophysis is also interlocking and lumbar-like. A second vertebra is clearly from the lumbar region, judging from the zygapophysis which has the usual interlocking character with a high, thin, neural spine.

The fragments of the pelvis and limb bones found with the holotype are rather small in proportion to the skull and jaws just described. The forearm bones are of light weight and short. The body of the ischium is broadly expanded above the acetabulum. The latter is small but deep and the obturator foramen is apparently of large size. The femur is represented by two shafts which are rather light in structure. The length of the femur cannot be determined from the remains at hand.

The feet are represented by the fragments of two proximal phalanges and a complete bone of the median row. The latter is depressed (due in part to crushing), and broad, with the articulation for the terminal phalanx carried well up on the dorsal face; the articulation is, however, groove-like and not roundly elevated above the shaft of the bone as in *Agriochœrus* and especially in *Diplobunops*; but rather more like that in the protoreodonts and oreodonts. Whether the shape of the ungual phalanges are agriochœrid or protoreodont in structure, it is impossible to determine from the material at hand.

The anterior portion of a skull with the cheek dentition well preserved, and a mandibular ramus, Carnegie Museum No. 11904, found in the Duchesne River Oligocene, immediately below the "Asphalt Ridge Conglomerate," five miles south of Vernal, Utah, is provisionally regarded as a paratype of the above described species. According to the report by Mr. Kay, in charge of the field party, the horizon in which the present specimen was found is approximately that in which the holotype was found, Randlett horizon. [This was a misapprehension, however. Mr. Kay considers the horizon, from which C. M. No. 11904 was taken, to be the upper part of the Halfway Horizon. (Personal communication, July 12, 1934.) J. J. Burke.] The description of the facial region and the muzzle of No. 11904, under description, was included with the description of the holotype. The noteworthy differences in the dentition of the two specimens are as follows: Premolars in No. 11904 are slightly further advanced; P^2 of greater transverse diameter posteriorly; P^3 with a distinct vertical rib on the postero-internal face of the protocone; and the indication of the posterior inner crescent further emphasized than in the holotype described above. Furthermore M^3 in 11904 has no protoconule while in the holotype there is a slight indication of such a tubercle.

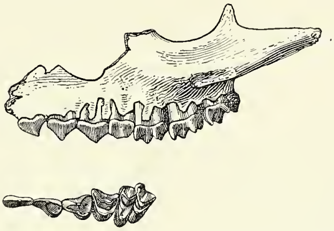

FIG. 4. *Mesagriochœrus primus* Peterson, gen. et sp. nov., paratype C. M. No. 11904, anterior portion of skull from left side and occlusal view of P^1-M^1 left. × ½.

The characters of the lower jaw fragment are a repetition of those already described, including the long and narrow molar series. P_3 and P_4 are closely similar to those in the holotype.

A fragment of a right ramus, No. 11903, with mutilated P_2 and P_3 and the second and third molars present, appears to belong to the species described above but gives no additional information. The specimen was found in practically the same horizon as that just described.

A third lower jaw, No. 11904A, of smaller size than those just described, and found with them, is provisionally placed with this series. The crowns of the anterior premolars are broken off but the alveolar border is complete and does not show the short diastema between P_1 and P_2 characteristic of the species just described. Judging from the size and shape of the root, P_1 is caniniform, characteristic of the group, but the absence of a diastema back of this tooth leads me to believe that we may be dealing with a different species from that described above. The crown of P_4 is partly broken anteriorly, but from what remains I am able to judge that its development is closely similar to that of P_4 in the lower jaw with the holotype already described. As in the latter specimen there is no evidence of a tubercle on the postero-internal angle. In all their detailed structure the molars are closely similar to those in the holotype.

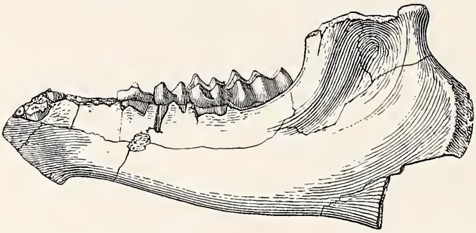

FIG. 5. *Mesagriochœrus primus* Peterson, gen. et sp. nov., C. M. No. 11904A, external view of left mandibular ramus. × ½.

The mandibular ramus is thin, deep, with a large angle, a correspondingly large pterygoid fossa and in all detailed structure it is similar to the ramus of the agriochœrids and the oreodonts. If the locality, five miles south of Vernal, Utah, should, after all, prove to be geologically later than that at Point Randlett, where the holotype of *Mesagriochœrus primus* was found, the three specimens, Nos. 11904, 11904A and 11903, just described, may well pertain to a distinct species. [As indicated above, Mr. Kay holds that the sediments from which these specimens were collected belong in the Halfway, the horizon immediately above the Randlett Horizon. J. J. Burke.] In comparing *Mesagriochœrus* with *Protagriochœrus* it is at once observed that the latter genus is slightly over one fifth larger,[11] premolars relatively larger, and P^4 not nearly as far along with regard to the indication of its molariform structure as that in *Mesagriochœrus.* While the general detailed structure of the molars is very similar, the protoconule in the species under description is considerably less developed. The two genera here compared are quite similar and it seems quite probable that *Protagriochœrus* stands ancestral to *Mesagriochœrus.*

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[11] Comparative size obtained from the respective measurements of the upper cheek-dentition.

MEASUREMENTS Skull	No. 11893 Holotype	No. 11904 Paratype
Anterior border of orbit to premaxillary	72 mm.	
Postorbital process of malar to anterior alveolus of P^1	62 mm.	58 mm.
Vertical diameter of skull opposite the orbit	52 mm.	48 mm.
Antero-posterior diameter of orbit	20 mm.	20 mm.
Vertical diameter of orbit	18 mm.	18 mm.
Antero-posterior diameter incisors to M^3	85* mm.	
Antero-posterior diameter P^1 to M^3	60* mm.	60 mm.
Antero-posterior diameter premolar series	32* mm.	30 mm.
Antero-posterior diameter of molar series	30* mm.	30 mm.
Antero-posterior diameter of P^1 at base of crown	7 mm.	7 mm.
Transverse diameter of P^1 at base of crown	3 mm.	3 mm.
Antero-posterior diameter of P^2	8 mm.	8 mm.
Transverse diameter of P^2 near posterior border	3 mm.	5 mm.
Antero-posterior diameter of P^3 at base of crown	8.5 mm.	8.5 mm.
Transverse diameter of P^3 opposite the deuterocone	6 mm.	6 mm.
Antero-posterior diameter of P^4	8 mm.	7 mm.
Transverse diameter of P^4 opposite the deuterocone	7.5 mm.	7.5 mm.
Antero-posterior diameter of M^1	9.5 mm.	
Transverse diameter of M^1 opposite mesostyle and posterior inner crescent	9.5* mm.	10 mm.
Antero-posterior diameter of M^2	12 mm.	11 mm.
Transverse diameter of M^2, same measurement	12* mm.	12 mm.
Antero-posterior diameter of M^3	13* mm.	12 mm.
Transverse diameter of M^3, same measurement	12* mm.	11* mm.
Transverse diameter of M^3, anterior face		13 mm.
Lower Jaw		
Depth of ramus at P_4	21 mm.	21 mm.
Depth of ramus at M_3	29* mm.	29 mm.
Incisors to M_3	83* mm.	
Length P_3-M_3	56 mm.	56 mm.
Length of molar dentition	39* mm.	39 mm.
Antero-posterior diameter of P_1 at base	7 mm.	
Transverse diameter of P_1 at base	4 mm.	
Antero-posterior diameter of P_2 at base	8 mm.	
Transverse diameter of P_2	3 mm.	
Antero-posterior diameter of P_3 at base of crown	9 mm.	9 mm.
Transverse diameter of P_3	3.5 mm.	4 mm.
Antero-posterior diameter of P_4 at base of crown	10 mm.	9 mm.
Transverse diameter of P_4 opposite the deuteroconid	4.5 mm.	4.5 mm.
Antero-posterior diameter of M_1	9 mm.	8.5 mm.
Transverse diameter of M_1 posterior crescent	6 mm.	6 mm.
Antero-posterior diameter of M_2	11* mm.	12 mm.
Transverse diameter of M_2	7 mm.	7 mm.
Antero-posterior diameter of M_3		18 mm.
Transverse diameter of M_3 posterior crescents		7 mm.

*Indicates approximate measurement.

Family HYPERTRAGULIDÆ

Leptomeryx (?) **minutus** sp. nov.

Holotype: Fragment of right lower jaw with P_4, M_1 and M_2 in position, Carnegie Museum No. 11913.

Horizon: Duchesne River Oligocene; Lapoint Horizon.

Locality: North side of "Red Narrows," east of Tridell, Uinta County, Utah.

Specific characters: The apices of proto- and deuteroconids of P_4 more completely separated and the postero-internal tubercle of less development than in the eastern forms, while the antero-internal body of the tooth is nearly equally developed to that in other species. The molars appear to be equally hypsodont to those in the known species; the exit of the external cross-valley is also more solidly filled as in some forms of *Leptomeryx* (*L.* (?) *evansi*) and less styliform than in *Leptotragulus*, while the styloid-like cingulum on the antero-internal angle of M_2 is present as in *Leptotragulus*; absent in *Leptomeryx*. The specimen from the Duchesne River Oligocene is smaller than any hypertragulid heretofore discovered in the eastern Oligocene or in the Uinta Eocene.

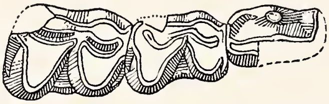

FIG. 6. *Leptomeryx? minutus* Peterson, sp. nov., holotype, C. M. No. 11913. P_4-M_2 right. × 4.

MEASUREMENTS

Length P_4-M_2	13	mm.
Length P_4	4	mm.
Transverse diameter M_1	3	mm.
Length of M_1	4	mm.
Length of M_2	4.5	mm.
Transverse diameter M_2	3	mm.

While the specimen above described appears to represent the hypertragulids it is provisionally placed in the genus *Leptomeryx*, pending the discovery of more complete material.

Order **PERISSODACTYLA**
Family HYRACODONTIDÆ
Subfamily Triplopodinæ

Epitriplopus medius sp. nov.

Holotype: Maxillary with P^3-M^2 represented, Carnegie Museum No. 11915.

Horizon: Base of Duchesne River Oligocene. Randlett horizon.

Locality: Two miles northeast of Randlett Point, Uinta County, Utah.

Specific characters: P^3 with proto- and metalophs slightly separated on the inner face of the crown. P^4 with proto- and metalophs well separated internally; the base of the internal exit of the cross-valley is, however, closed up, forming a large and relatively deep median fossette. Furthermore, there is present on P^4 a very weak crista and a cingulum-like ridge on the posterior half of the ectoloph. M^1 of approximately the same diameter as in *Epitriplopus uintensis*, but with a heavier internal cingulum at exit of the cross-valley. There is a well marked cingulum on the posterior half of the ectoloph on M^1, absent on M^2, while in *E. uintensis* there are no external cingula on the molars. M^2 shorter than in *E. uintensis.*

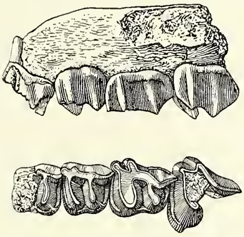

Fig. 7. *Epitriplopus medius* Peterson, sp. nov., holotype C. M. No. 11915, external view of portion of left maxillary and occlusal view of P^3-M^2 left. × ½.

Measurements

Length of cheek-teeth dentition P^3-M^2	59 mm.
Length of P^3, approximately	13 mm.
Transverse diameter opposite metaloph	12 mm.
Length of P^4, ectoloph measurement	13 mm.
Transverse diameter P^4, opposite protoloph	12 mm.
Length of M^1, ectoloph measurement	18 mm.
Transverse diameter of M^1, opposite protoloph	15 mm.
Length of M^2, ectoloph measurement	18 mm.
Transverse diameter of M^2, opposite protoloph	17 mm.

A mandibular ramus, C. M. No. 11916, represented by the symphysis; and a second fragment which contains the roots of P_2 and P_3 and the complete P_4, together with other fragments of the jaw, are of considerable interest in this connection. The geological horizon is well up in the Duchesne Oligocene, approximately the same as that in which the titanothere quarry (now referred to as the Lapoint horizon), eleven miles west of Vernal, Utah, is located. P_2 of this specimen is single rooted and very small as in *Mesamynodon medius* Peterson.[12] P_3 is of approximately the same antero-posterior diameter, while P_4 is shorter than in the latter species. This portion of the jaw is perhaps most nearly similar to that corresponding part in *Mesamynodon*, while the symphysis, if pertaining to the same specimen, is certainly not an amynodont, but most likely a triplopodine, judging from the relatively small size and round section of what remains of the canine roots.

Subfamily HYRACODONTINÆ

Hyracodon primus sp. nov.

Holotype: Fragment of maxillary with P^4-M^3, Carnegie Museum No. 11914.

Horizon: Duchesne River Oligocene; Lapoint Horizon.

Locality: One-half mile north of the Vernal-Lapoint road, about fourteen miles west of Vernal, Utah.

Specific characters: In detailed structure the teeth agree most closely with those in *Hyracodon petersoni* Wood,[13] except the less hypsodont crowns; the more prominent external cingulum of P^4, M^1 and M^2; and the greater convexity of the posterior portion of the

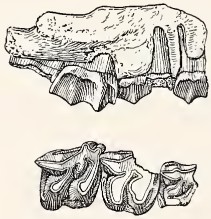

FIG. 8. *Hyracodon primus* Peterson, sp. nov., holotype C. M. No. 11914, external view of portion of right maxillary and occlusal view of P^4-M^2 right. × ½.

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[12] Ann. Car. Mus., Vol. XXI, 1931, p. 71.

[13] Ann. Car. Mus., Vol. XVI, 1926, p. 315.

ectoloph on P^4 and M^1. This convexity of M^2 is much reduced and more nearly approaches the concave external face of the metacone in the molars of *H. petersoni*. The crista of P^4 and the molars are of somewhat greater development than in the White River species.

MEASUREMENTS

Length of cheek-dentition P^4-M^3, approximately	53 mm.
Length of P^4	12 mm.
Breadth of P^4	12 mm.
Length of M^1, ectoloph measurement	15 mm.
Breadth of M^1, opposite metaloph	15 mm.
Length of M^2, ectoloph measurement	17 mm.
Breadth of M^2, opposite protoloph	17 mm.
Breadth of M^2, opposite metaloph	14 mm.

VIII. NEW DUCHESNE RIVER RODENTS AND A PRELIMINARY SURVEY OF THE ADJIDAUMIDÆ

By J. J. Burke

The two species of Duchesne River rodents described in this paper were discovered by Carnegie Museum field parties working in the Uinta Basin, Utah, in 1931 and 1932. At the base of the Duchesne River Oligocene Series in the Randlett Horizon, the *Paramyidæ* are represented by a new species, *Leptotomus kayi* m., which approaches related forms found in the underlying Uinta Eocene Series. This was the most complete rodent specimen discovered in this horizon, but scattered teeth recovered in the same beds show that species of the *Sciuravus* and *Tillomys* type persisted to the base of the Duchesne River Oligocene.

In the uppermost horizon of the Duchesne River Oligocene Series, the Lapoint, but one rodent was found. The latter, however, appears to give all that might be desired in the way of an ancestor for the interesting Sciuromorph genus *Adjidaumo*; the family *Adjidaumidæ* has hitherto been known only from higher Oligocene horizons. The specimen, described herein as a new genus and species, *Protadjidaumo typus* m., adds to the Oligocene components of the Duchesne River fauna.

The illustrations in this paper are from drawings by Mr. Sydney Prentice.

Order **SIMPLICIDENTATA** Lilljeborg

Family PARAMYIDÆ Miller and Gidley

Genus LEPTOTOMUS[1] Matthew

Leptotomus kayi sp. nov.

Holotype: Fragmentary left maxillary with P^4, M^1, M^2 and M^3 in place, Carnegie Museum Cat. Vert. Foss., No. 11930.

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[1] Matthew proposed *Leptotomus* as a subgenus of *Paramys* in 1910 ("On the Osteology and Relationships of *Paramys*, and the Affinities of the *Ischyromyidæ*," Bull. Amer. Mus. Nat. Hist., Vol. 28, Art. VI, p. 50). I believe this group of the *Paramyidæ* should be raised to full generic status, however, along with *Ischyrotomus*.

Issued Nov. 19, 1934.

Horizon: Duchesne River Oligocene Series, Randlett Horizon, near contact with Myton Member[2] (Horizon C of Peterson), Uinta Eocene Series.

Locality: Two miles northeast of Randlett Point, Uinta County, Utah.

Diagnosis: Cheek teeth brachyodont, the pattern recalling that of *Prosciurus*; low intermediate tubercles on protolophs and metalophs of P^4, M^1 and M^2, the metaconules more prominent than the protoconules; external intermediate cuspules on P^4 and the molars; molars with prominent anterior but much reduced posterior cingula and slight internal enamel invaginations. Low posterior transverse crest in M^3. P^4 molariform, its anterior cingulum more reduced than that of molars, the posterior cingulum prominent, the metacone and metaconule nearly equal in size. Species larger than *Leptotomus grangeri* Matthew.

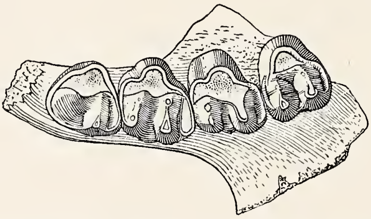

FIG. 1. *Leptotomus kayi* Burke, holotype, C. M. No. 11930, maxillary with P^4-M^3 left, ×2.

Anterior to P^4 the maxillary is shattered and P^3 is not preserved. P^4 is almost as large as the molars, is not prolonged forward, and has a well-developed anterior cingulum. Its anterior cross-valley is not as wide as the corresponding cross-valleys in the molars, and the posterior cingulum is low. P^4 bears a very small cuspule between the external cusps.

In the molars the anterior cingula are well-developed. The posterior cingula were much reduced. In M^1 the external intermediate cuspule is prominent. A slight enamel invagination occurs in the internal face of this molar. M^2 is badly worn in the region of the protoloph, but the presence of a low protoconule is still indicated. The external intermediate cuspule is somewhat larger than the corresponding cuspule in M^1, and an enamel invagination in the postero-internal wall of the tooth is a little shallower than the invagination seen in M^1. M^3 bears a complete anterior transverse crest. The posterior basin has been badly worn, but a short crest runs internally from what appears to be a low external intermediate cuspule, and there are indications of a low posterior transverse crest.

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[2] The term "Myton Member" has been proposed for the Upper Uinta, C of Peterson, by Horace Elmer Wood 2nd ("Revision of the Hyrachyidæ," Bull. Amer. Mus. Nat. Hist., Vol. LXVII, Art. V, p. 242, 1934). In this paper Wood also proposes the term "Wagonhound Member" for the Lower Uinta, A+B of Peterson.

The zygoma is heavy and sturdy, and begins to flare out laterally posterior to M^1. Anteriorly it extends obliquely upward and forward.

This species agrees best with a smaller form, probably a distinct species, which is found in the Myton Member of the Uinta Eocene Series, the lower jaw of which resembles that found in *Leptotomus grangeri* Matthew. P^4 was the only superior cheek-tooth found with the type of *Leptotomus grangeri* Matthew. From it, P^4 of both *Leptotomus kayi* m. and the Myton Member species differ in being more molariform, the trigonal outline seen in P^4 of *Leptotomus grangeri* Matthew is less evident, and the anterior cingulum is more reduced. In *Leptotomus kayi* m. the metacone and metaconule appear to be nearer the same size than in *Leptotomus grangeri* Matthew, and the Duchesne River Oligocene species exceeds both *Leptotomus grangeri* Matthew and the species from the Myton Member in size.

MEASUREMENTS	mm.
P^4 antero-posterior	4.8
P^4 transverse	5.4
M^1 antero-posterior	4.8
M^1 transverse	5.7
M^2 antero-posterior	4.9
M^2 transverse	5.0
M^3 antero-posterior	5.1
M^3 transverse	5.0

Family ADJIDAUMIDÆ Miller and Gidley

The discovery of *Protadjidaumo typus* m. in the Duchesne River Oligocene Series by the Carnegie Museum field party of 1932 necessitated a comparison of the latter species with later Oligocene *Adjidaumidæ* which have been included by various writers in the past in the genus *Adjidaumo*. After a study of material in the collections of the Carnegie Museum, the writer was enabled, though the generosity of Dr. Walter Granger, Curator of Fossil Mammals at the American Museum of Natural History, to borrow and study type material at the latter institution, and has recently, through the kindness of Mr. Albert E. Wood, secured the loan of some excellent specimens from the latter's private collection. It is planned to embody the results of the study of this material in a later paper dealing more fully with the family *Adjidaumidæ*, and the following descriptions are to be considered as preliminary to a fuller treatment of the material.

Genus PROTADJIDAUMO gen. nov.

Genotype: **Protadjidaumo typus** sp. nov.

Holotype: Fragment of left ramus of mandible with P_4, M_1 and M_2, Carnegie Museum Cat. Vert. Foss., No. 11931.

Horizon: Duchesne River Oligocene Series, Lapoint Horizon.

Locality: Fourteen miles west of Vernal, Uinta County, Utah, one-half mile north of Vernal-Lapoint road.

Diagnosis: Pattern of cheek-teeth essentially as in *Adjidaumo*, but cusps more bunoid and connecting crests weaker, P_4 with low posterior cingulum connecting with hypolophid, anterior valley of M_1 opening freely externally.

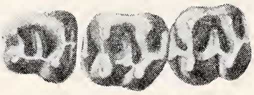

FIG. 2. *Protadjidaumo typus* Burke, holotype, C. M. No. 11931, P_4-M_1 left, ×10.

If not directly ancestral to the genus *Adjidaumo* in later Oligocene horizons, *Protadjidaumo* is certainly closely related to the latter genus. By converting the posterior cingulum of P_4 into a cingulum crest (a process which appears to be under way already), developing a dam near the external exit of the anterior valley of M_1, raising and strengthening its connecting crests and attaining a more crescentic condition of its outer cusps, *Protadjidaumo typus* might easily give rise to a conservative species of *Adjidaumo* such as *Adjidaumo minutus* (Cope). On the other hand, *Protadjidaumo* appears to have progressed too far in the direction of *Adjidaumo* to have led up to the species included in the proposed new genus *Paradjidaumo*, which is described later in this paper.

MEASUREMENTS	mm.
P_4 antero-posterior	1.1
P_4 transverse	1.0
M_1 antero-posterior	1.1
M_1 transverse	1.1
M_2 antero-posterior	1.2
M_2 transverse	1.1

Genus ADJIDAUMO Hay

Adjidaumo douglassi sp. nov.

Holotype: Fragment of right ramus of mandible with M_{1-3} in place, Carnegie Museum Cat. Vert. Foss., No. 1957.

Horizon: Upper Oligocene.[3]

Locality: White Butte, North Dakota.

Diagnosis: A little larger than *Adjidaumo minimus* (Matthew) and smaller than *Adjidaumo minutus* (Cope); inferior molars with crescentic external cusps, steep outer walls, crowded anterior valleys, deep central basins, and reduced anterior cingula; posterior valley wide on M_1 and on M_2, merely indicated on M_3, median transverse crest of M_3 joined with entoconid, forming fossette internal to hypoconid, crest from entoconid in M_{1-2} oblique and joined with postero-external wall postero-internal to hypoconid.

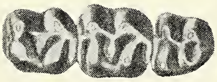

FIG. 3. *Adjidaumo douglassi* Burke, holotype, C. M. No. 1957, M_{1-3} right, ×10.

In size this species approaches *Adjidaumo minimus* (Matthew) but shows considerable advance over the latter and a somewhat lesser advance over *Adjidaumo minutus* (Cope) in the more crescentic condition of its external cusps, in having higher and more oblique connecting crests, and deeper central basins which are tending to become fossettes. In *Adjidaumo minimus* (Matthew) the posterior valleys of M_1 and M_2 are relatively narrow and the posterior cingulum crests weak, while the opposite condition holds in *Adjidaumo douglassi* m.

[3] This specimen was collected by Earl Douglass on Nov. 23, 1905. Douglass' field labels give the following data regarding the horizon and the locality from which it was taken:

Horizon: "White River, above nodular Oreodon Bed, in gray-greenish sand above hard green sandstone containing *Aceratherium tridactylum, Mesohippus,* etc."

Locality: "White Butte, 50 mi. S.W. of Dickinson, N. Dakota near Sand Creek."

The "gray-greenish sand" mentioned above is No. 6 of Douglass' White Butte section in "A Geological Reconnaissance in North Dakota, Montana and Idaho," Ann. Car. Mus., Vol. V., No. VIII, pp. 284-285, 1909.

MEASUREMENTS

	mm.
M_1 antero-posterior	1.1
M_1 transverse	0.9
M_2 antero-posterior	1.0
M_2 transverse	1.1
M_3 antero-posterior	0.9
M_3 transverse	0.9
Length of molar series	2.5

Genus PARADJIDAUMO gen. nov.

Genotype: **Paradjidaumo minor** (Douglass).

Eumys minor Douglass, Trans. Amer. Philos. Soc., N. S., Vol. XX, 1901, p. 252.
Gymnoptychus minor Matthew, Bull. Amer. Mus. Nat. Hist., Vol. II, 1903, p. 215.

Holotype: A right lower jaw with P_4 and M_1 in place, Carnegie Museum Cat. Vert. Foss. No. 735.

Horizon of the holotype: Titanotherium Beds, Lower Oligocene.

Locality of the holotype: Pipestone Creek, Jefferson County, Montana.

Referred Species: **Paradjidaumo nasutus** (Cope).

Gymnoptychus nasutus Cope (in part), Pal. Bull. 16, 1873, p. 6 (The lower jaw first described, not the skull).[4]
Gymnoptychus trilophus Cope, Pal. Bull. 16, 1873, p. 6.[5]

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[4] In the protograph, after describing the lower jaw, Cope wrote of this skull, "The anterior part of a cranium *probably* belongs to the same species." (Italics mine). In the table of measurements, the measurements of the skull are preceded by those of the lower jaw. In 1874 (Ann. Rpt. U. S. Geol. and Geog. Surv. Terr., p. 476) both the lower jaw (Am. Mus. 5401) and the portion of a skull (Am. Mus. 5367) are included under *G. trilophus*. But in 1884 (Vert. of the Tert. Form. of the West, explanation of fig. 21, Pl. LXV, Cope makes the statement that this was the skull "upon which the species *G. nasutus* was established." In this paper of Cope's, the skull was rather doubtfully placed under *G. minutus*. While I am not sure that this specific reference is correct, I do not hesitate to refer the specimen to *Adjidaumo*.

[5] In this paper, despite the fact that the species *nasutus* had page priority in the first description, Cope relegated it to the synonomy of *trilophus* without giving any reason for his action. I am convinced that Cope's procedure in this and subsequent descriptions contributed to a confusion of types and beclouded the true relationships of the various species described under *Gymnoptychus* in Pal. Bull. 16, and feel that further acquiescence to this disposition of the species would only lead to a more involved taxonomic snarl.

Gymnoptychus trilophus Cope (in part), Ann. Rpt. U. S. Geol. and Geog. Surv. Terr., 1874, p. 476 (Not the skull).

Gymnoptychus trilophus Cope, American Naturalist, Vol. XVII, 1883, p. 51, fig. 5e.

Gymnoptychus trilophus Cope, Vert. of the Tert. Form. of the West, Book I, 1884, p. 826, pl. LXV, figs. 31-34.

Adjidaumo trilophus Hay, Science, N. S. 10, Vol. 33, No. 243, 1889, p. 253.

Gymnoptychus liolophus Matthew, Bull. Amer. Mus. Nat. Hist., Vol. II, 1903, p. 215.

Holotype: A lower jaw with DP_4, M_1 and M_2 in place, American Museum of Natural History No. 5401.[6]

Horizon of the holotype: Oreodon Beds, Middle Oligocene.

Locality of the holotype: Cedar Creek, Logan County, Colorado.

Generic diagnosis: $P\frac{1}{1}$ $M\frac{3}{3}$. Cheek-teeth more hypsodont and progressively more lophodont than in *Adjidaumo*: pattern of unworn cheek-teeth resembling that of *Adjidaumo*, but somewhat simpler, anterior and posterior valleys shallow and narrow. Cingula, excepting anterior cingula of $P\frac{4}{4}$ elevated into marginal crests; antero-external ridge lacking from inferior molars; "*Adjidaumo*" pattern evanescent, moderate wear reduces superior surface of crown to characteristic omega-like design of three transverse lophs.

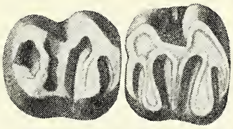

FIG. 4. *Paradjidaumo minor* (Douglass), holotype, C. M. No. 735, P_4 and M_1 right, ×10.

The family *Adjidaumidæ*, as now known, appears to be divisible into two major groups of species. The first of these groups consists of species with brachyodont cheek-teeth which retain the antero-external ridge on the inferior molars and have relatively deep anterior and posterior valleys. This division includes *Protadjidaumo typus* m.,

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[6] This lower jaw has been regarded as the type of *Gymnoptychus trilophus* Cope, probably due to the fact that its measurements occur first in the tables accompanying the description of *Gymnoptychus trilophus* Cope on p. 476 of the Ann. Rpt. U. S. Geol. and Geog. Surv. Terr. in 1874. Reference to the type description of *Gymnoptychus nasutus* Cope in Pal. Bull. 16, p. 6, however, reveals that identical measurements appear for the lower jaw described by Cope under that title in 1873. Furthermore, in the same paper, the measurements accompanying the description of *Gymnoptychus trilophus* Cope are of a specimen with four cheek-teeth. This specimen has not been located in the type collection of the American Museum of Natural History.

Adjidaumo minimus (Matthew), *Adjidaumo minutus* (Cope), and *Adjidaumo douglassi* m. described above. A second and more progressive group includes species in which the cheek-teeth have higher crowns than those of the last assemblage, and in which the antero-external ridge is lacking from the inferior molars. In these species the pattern showing at the crown of unworn cheek-teeth is similar to that of *Adjidaumo*, although somewhat simpler, but there is the same arrangement of paired anterior and posterior transverse crests, and a median transverse crest extending across the central basin. The anterior and posterior valleys are shallow and crowded, however, and this pattern gives way at an early stage of wear to the familiar one of three transverse lophs. Apparently there is a tendency toward a more lophodont condition in this group, commensurate with the increased height of the crowns of the cheek-teeth, and this lophodont state is being brought about through the elimination of an earlier pattern similar to that of *Protadjidaumo* and *Adjidaumo*. For this group of species the generic name *Paradjidaumo* is proposed, the genus to include the species *Paradjidaumo minor* (Douglass) and *Paradjidaumo nasutus* (Cope). The characters of the genus indicate that it should be regarded as a separate phyletic line within the *Adjidaumidæ*, derived from a common ancestral stock with *Protadjidaumo* and *Adjidaumo*, but without known intermediate forms between it and the latter genera.

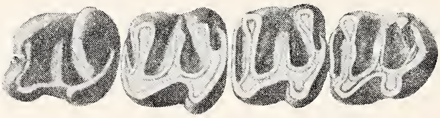

FIG. 5. *Paradjidaumo nasutus* (Cope). Referred specimen, C. M. No. 1033, P_4-M_3 left, ×10. P_4 was not entirely erupted and has been lifted into place beside M_1.

IX. MYTONOLAGUS, A NEW LEPORINE GENUS FROM THE UINTA EOCENE SERIES IN UTAH

By J. J. Burke

The fossils described in the following paper were collected by field parties of the Carnegie Museum in the course of exploration of the Upper Eocene sediments of the Uinta Basin, in northeastern Utah, during the field seasons of 1925, 1932, and 1933. The bulk of the collection was taken from a locality known to the field parties as the "Myton Pocket," a small area of badlands in Uinta County located about six miles south and east of Myton, Utah. Fossil mammals were first discovered in this locality by the late O. A. Peterson in 1912, and many of the Uinta specimens described by the latter author[1] in 1919 were collected in this area. The exposures from which the material under description was taken are included in the Myton Member of the Uinta Eocene Series.

The first specimen discovered came from one of the sandstones forming the floor of the Myton Pocket, and a fruitless search was made of this and other sandstones of the region for better material. Later, however, several specimens were discovered in the alternating bands of green and dark brown shales which are characteristic of the area. Our best collections were made immediately after heavy rains, when the shale surfaces were washed clean and the small specimens stood out clearly against the shale slopes, but the collector was hampered by heavy gumbo mud which clung to his boots.

A note telling of the discovery of this material appeared in *Science* in February, 1933.[2] In this article mention is also made of the finding of a leporine specimen in the Duchesne River Oligocene Series. Since this announcement, specimens belonging to this group have also been discovered near the top of the Wagonhound Member of the Uinta

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[1] Peterson, O. A., "Report upon the Material Discovered in the Upper Eocene of the Uinta Basin by Earl Douglas(s) in the Years 1908-1918 and by O. A. Peterson in 1912." Ann. Carn. Mus., Vol. XII, Art. 2, pp. 40-168, figs. 1-19, Pls. XXXIV-XLVII, 1919.

[2] Burke, J. J., "Eocene Lagomorpha." Science, N. S. Vol. 77, No. 1990, p. 191, Feb. 17, 1933.

Issued Nov. 19, 1934.

Eocene Series. Both the Duchesne River and the Wagonhound specimens are fragmentary, but are referred to the same genus as the Myton fossils.

The *Science* article stated that "at least three species" are represented in our collection. Discovery of new material and further comparative study convinces me, however, that it is unwise to recognize more than one species in the collection from the Myton Member. The species under description approaches the Leidy genus *Palæolagus* in its principal characters, but lacks the specialization found in the latter, and appears to deserve generic distinction from the Oligocene form.

The writer gratefully acknowledges the aid of the following institutions and individuals in this study: the late O. A. Peterson, under whose supervision the work was begun and for whom the species of *Mytonolagus* described below is named; the American Museum of Natural History and Dr. Walter Granger for the privilege of study of collections; Princeton University through Professor W. J. Sinclair, and the National Museum through Mr. C. W. Gilmore, for the loan of comparative material; Dr. Horace Elmer Wood II, Mr. Albert Wood, Mr. Harold Cook, and Mr. R. V. Witter for the loan of specimens from their private collections; and Mr. Sydney Prentice, of the Carnegie Museum, from whose drawings the illustrations for this paper were taken.

Order **DUPLICIDENTATA** Illiger

Family LEPORIDÆ Gray

Genus MYTONOLAGUS gen. nov.

Genotype: **Mytonolagus petersoni** sp. nov.

Holotype: Left maxillary with P^2-M^2. RM^3. Left ramus of mandible with P_3-M_3 in place. Fragments of right ramus of mandible and RP_3-RM_2, portion of right palatine, C. M. Cat. Vert. Foss. No. 11937.

Paratypes: Fragment of right maxillary with P^3-M^1; LP^4; fragment of left ramus of mandible containing portion of incisor, base of LP_3 and LP_4, LM_1; RP_4; fragments of proximal and distal extremities of right humerus; head of left humerus; proximal portions and fragments of shafts of right and left tibiæ, all found associated and presumably belonging to the same individual, C. M. Cat. Vert. Foss. No. 11935.

Left maxillary with P^3-M^2 and DP^4 removed to expose P^4, C. M. Cat. Vert. Foss. No. 11932.

Horizon: Myton Member (Horizon C of Peterson), Uinta Eocene Series.

Locality: Myton Pocket, Little Pleasant Valley, Uinta County, Utah, about six miles south and east of Myton, Duchesne County, Utah.

Diagnosis: Known species small, approaching *Palæolagus haydeni* Leidy in size, nearer *Palæolagus brachyodon* Matthew in general construction, but cheek teeth less hypsodont and more transverse, their protomere faces with lower gradients; molarization of premolars less advanced, molars less reduced; maxillary and ramus of mandible narrower and weaker in premolar region; external borders of superior and inferior tooth rows more angular in outline, premolars less transverse, relative to molars, than in *Palæolagus*; P^3-^{4} each with only one strong outer rootlet and with shallow internal groove. P^2 near M^3, P^4 near M^2 in size; M^1 the largest and most transverse of superior cheek teeth. P_3 approximating M_3 in size, M_1 and M_2 of nearly equal size and most transverse of inferior cheek teeth. Internal reëntrants of P_3 not persistent; main external reëntrant not extending more than half-way across triturating surface of crown.

Description: The maxillary of the holotype is deepest in the region of P^4. It is generally shallower than that found in *Palæolagus*, and broader in the molar region. In the vicinity of the premolars it shows a somewhat weaker construction than that seen in *Palæolagus brachyodon* Matthew, and is more compressed along the antero-external border than the maxillary of the latter species, while the zygoma does not appear to have been as strong. The position of the palatine foramina and the relation of the maxillary to the palatine bones are essentially as in *Palæolagus*.

No superior incisors were found with the type material, but C. M. No. 11940 includes an I^2 from the Myton Member of the Uinta Eocene Series which may belong with this species. It is slenderer than that found in *Palæolagus haydeni* Leidy, and more compressed transversely; the groove on the anterior face is less prominent than in the latter species.

A P^2 is preserved in but one specimen, the holotype. It is a small tooth, well worn, and shows a trilobate triturating surface. The principal lobe = paracone[3] is central, elongate longitudinally and produced anteriorly beyond the external and internal lobes. The internal lobe = protocone is the smallest of the three and separated from the central lobe anteriorly by a longitudinal valley. Postero-external to the central lobe occurs a third lobe = metacone, separated from the paracone anteriorly by a narrow valley which takes a postero-external course toward the posterior wall. P^2 may be described as having but a single root, but a strong vertical groove on the antero-external side of this root above and between the paracone and metacone lobes indicates a bi-fanged history. I find a groove similarly placed in P^2 of a specimen of *Desmatolagus gobiensis* M. & G. now in the collection of Carnegie Museum,[4] but in the latter tooth the groove is more prominent. In both cases the root shows a cross-section at the base similar to that observed by Forsyth Major in P^3 of a specimen which he refers to *Titanomys visenoviensis* H. V. Mey.[5] The metacone lobe of this tooth shows less reduction than in *Palæolagus temnodon* Douglass[6] or in *Palæolagus brachyodon* Matthew, and the paracone lobe is relatively larger than in the latter species.

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[3] The molar nomenclature of Osborn is applied to the premolars of the species under description without commitment to any theory of cusp homologies in these teeth.

The disproportion in size between P^2 and P^3 appears to be greater in *Mytonolagus petersoni* m. than that usually found in the same teeth in *Palæolagus brachyodon* Matthew. In P^3 of the holotype the paracone is crescentic, with a worn shelf internal to it and separated from it by a portion of the lunate fold which enters from the antero-external corner of the crown. Wear has obliterated all traces of the internal notch. From the worn internal shelf of this specimen, an anterior "wall" = protoloph, extends toward the external side of the crown, but does not entirely subtend the anterior horn of the paracone from the anterior face of the tooth. Postero-external to the crescentic paracone appears the metacone, a gently rounded cusp which is attenuated anteriorly into a long spur which curves around the antero-external angle of the crown. Posterior to the metacone occurs a tiny transverse enamel notch, almost isolated as an island. Internal to the metacone and its anterior spur occurs a shallow longitudinal valley, partly separating the metacone and the paracone.

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[4] The American Museum of Natural History, through Dr. Walter Granger, Curator of Fossil Mammals, has generously presented several specimens of *Desmatolagus* to the Carnegie Museum.

[5] Major, C. J. Forsyth, "On Fossil and Recent Lagomorpha." Trans. Linn. Soc. Lond., Ser. 2, Vol. VII, p. 448, Pl. 39, fig. 5b, 1899.

[6] Douglass did not specify the holotype of *Palæolagus temnodon* Douglass in the protograph, "Fossil Mammalia of the White River Beds of Montana," Trans. Amer. Philos. Soc., N.S., Vol. XX, pp. 250-251, 1901. Douglass' No. 43 (now C. M. No. 725a) is mentioned first in the description and in the table of measurements and is regarded as the holotype. Douglass' Nos. 44 (now C. M. 725) and 45 (now C. M. 725b) are paratypes. The last specimen (C. M. 725b) is a *Palæolagus brachyodon* Matthew.

The P^3 of C. M. 11935 is of a younger individual than the holotype and has not received a great deal of wear. It shows a weak internal notch, not persistent to the base of the enamel. P^3 of this specimen also shows slight development of the protoloph; practically the entire anterior face of the paracone is exposed, while the metacone spur is short. P^3 of this and of one other specimen in which the roots can be observed show but one strong external rootlet.

The P^3 of C. M. 11932 is entirely unworn; the roots of DP^3 were still in place when the specimen was found. The protoloph in this tooth extends across the anterior face of the crown, descending to the antero-external angle to meet the spur from the metacone. The latter spur is stronger than the corresponding one in the holotype. P^3 of this specimen also shows a slight notch posterior to the metacone which may correspond to that seen in a similar position in the holotype. The internal notch shows only slightly at the triturating surface, although the internal margin of the tooth rises a little higher in the anterior portion, and a slight depression may indicate a trace of a separation into anterior and posterior portions of the crown at this place.

I believe that no particular stress can be placed on the variations seen in the protoloph in P^3 of this species. The protoloph also appears to show considerable variation in *Palæolagus brachyodon* Matthew and in *Desmatolagus gobiensis* M. & G.; Walker[7] describes a condition which seems to resemble that found in C. M. 11935 as characteristic of P^3 of *Palæolagus turgidus* Cope, but in all the specimens of P^3 of *Palæolagus turgidus* Cope which I have seen, in which wear had not eliminated the pattern showing at the crown surface, I have detected only one reëntrant in this region, the antero-external.

The protoloph of P^4 of the holotype of *Mytonolagus petersoni* m. is complete, the paracone strongly crescentic and the metacone reduced over that seen in P^3. The internal notch is not shown on the worn P^4 of this specimen, and at the present stage of wear the anterior horn of the paracone fuses with the protoloph, damming the lunate valley; the outer portion of the latter valley takes a common exit with the longitudinal valley at the antero-external corner of the crown. A small cuspule occurs in the outlet, and a smaller cuspule on the spur-like anterior shoulder of the metacone.

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[7] Walker, M. V., "Notes on North American Fossil Lagomorphs." The Ærend, Vol. II, No. 4, p. 234, 1931. Since this article was written, however, I have seen a specimen of *Palæolagus turgidus* Cope in the American Museum of Natural History, included under A. M. No. 12268 which shows the protoloph partly divided into two cusps. Such a construction might account for one of Walker's reëntrants.

As in P^3 of the same specimen, the internal notch is present in P^4 of C. M. No. 11935, but does not extend to the base of the enamel. The protoloph is also complete, as in the holotype, but the external outlet of the valleys is blocked by a cusp-like elevation of the crown in that region. Posterior to this place, the crown surface is depressed, but not to the level of the floor of the longitudinal valley, which is thus left isolated. A style-like cuspule is developed from the external shoulder of the metacone in this specimen; the notch posterior to the metacone participates in separating the cuspule from the metacone. P^4 of this specimen shows but one outer rootlet; the same condition is found in P^4 of all other specimens in which this region of the tooth can be examined. This rootlet is robust, transversely compressed and shows a faint shallow groove on its external side; the single rootlet in P^3 has already been noted. Probably in P^3 and P^4 of *Mytonolagus petersoni* m., the two outer rootlets which seem to characterize both P^3 and P^4 of the various species of *Palæolagus* have fused to form a single strong fang.

To expose P^4 of C. M. 11932 it was necessary to remove DP^4, which was still in place when the specimen was found. In general construction P^4 of this specimen resembles P^3, but the protoloph is nearly plane and although the outlet of the valleys at the antero-external corner of the crown is open nearly to the base, it is more constricted than in P^3 of the same specimen, or in P^4 of the holotype. The cuspules along the external border appear to have joined, together with the metacone, to form an external wall reminiscent of an ectoloph. The internal groove imparts more curvature to the internal margin of this tooth than it does to the same region in P^3.

The greater development of the internal groove in the premolars of *Palæolagus haydeni* Leidy as compared with that found in the corresponding teeth in this species should not, in my opinion, be taken as an indication of the rate of evolution of this character in the early *Leporidæ*. It is not only in *Palæolagus haydeni* Leidy, but also in

Palæolagus temnodon Douglass and in *Palæolagus agapetillus* Matthew (*non* Cope)[8] that we find the more transverse type of internal notch in the premolars, comparable with the incipient "Lepus pattern" of the molars. On the other hand, the internal notch in the premolars of *Palæolagus brachyodon* Matthew cannot be said to be much more pronounced than that seen in *Mytonolagus petersoni* m., and though more transverse in *Palæolagus turgidus* Cope and *Palæolagus intermedius* Matthew it does not yet appear on any of the premolars to be of the type seen in P^3 and P^4 of *Palæolagus haydeni* Leidy, where, in addition to the internal groove, an external portion of the fold cuts downward into the crown and shows in an isolated enamel island on the worn premolars, as it does in the molars. The prevalence of the shallow internal fold in the premolars of the species which compose what I term the "*turgidus* group" of *Palæolagus* including *Palæolagus brachyodon* Matthew, *Palæoloagus turgidus* Cope and *Palæolagus intermedius* Matthew, with which *Mytonolagus petersoni* m. appears to be allied, contrasts strongly with the more transverse fold seen in *Palæolagus temnodon* Douglass, *Palæolagus haydeni* Leidy and *Palæolagus agapetillus* Matthew (*non* Cope), a species association which may be termed the "*haydeni* group."[9]

Ehik[10] has seen fit to denominate various cuspules on the external borders of the crowns of the premolars of *Titanomys* in terms of the Osbornian nomenclature. In the case of *Mytonolagus petersoni* m. the variation in this region of the crown is considerable; I have observed somewhat similar variations in other duplicidentate species, notably in *Palæolagus brachyodon* Matthew and in *Desmatolagus gobiensis* M. & G. In the premolars of the species under description, these cuspules appear to be at times absent, or else joined to the extent that they are not distinguishable as distinct elements; furthermore, cuspules additional to those observed by Ehik are present in some of these teeth and further complicate the pattern. For these reasons I have not attempted to designate them by topographic terms. They appear to be cingular in derivation, and taking into account the variations which are commonly found in cingular elements, coupled with the fact that the pattern of the external side of the cheek teeth of *Mytonolagus petersoni* m. is already becoming obsolete and is affected by the degeneration of the external portion of the tooth, considerable variation in this region of the premolars cannot be regarded as unusual.

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[8] It should be kept in mind that Matthew was not certain that the species from the "upper levels of the White River beds" in Colorado was identical with *Palæolagus agapetillus* Cope. See Bull. Amer. Mus. Nat. Hist. Vol. XVI, Art. XXII, pp. 307-308, 1902. There is a possibility that the species described by Matthew is distinct from *Palæolagus agapetillus* Cope. Regardless of the specific status of *Palæolagus agapetillus* Cope, however, it, too, belongs in the *haydeni* group.

[9] Matthew appears to have been the first to recognize these species groups. See Bull. Amer. Mus. Nat. Hist., Vol. XIX, Art. VI, p. 218, 1903.

[10] Ehik, J., "The Right Interpretation of the Cheekteeth Tubercles of Titanomys." Ann. Mus. Nat. Hungarici, Vol. XXIII, pp. 178-186, figs. 1-5, 1926.

Unfortunately the external portion of M^1 of the holotype of *Mytonolagus petersoni* m. is lost, but the position of its external rootlets, which are still in place, indicates that it exceeded P^4 in transverse dimension to an extent approximating that to which P^4 exceeds P^3. A slight curvature in the enamel of the postero-internal margin indicates the very base of the internal notch.

In C. M. 11935, this tooth is complete and considerably less worn. The obliquity of the external border of this tooth contrasts strongly with the straighter outer border of P^4 of the same specimen. The protoloph sweeps outward to mark the greatest transverse extent of the crown and is separated from the paracone by a lunate valley similar to that seen in the premolars. A short valley from the postero-external side of the crown defines the concavity of the paracone and intervenes between the latter and the posterior wall of the crown, with which the paracone connects at the head of the valley. The posterior wall, external to this connection with the paracone, I consider to represent the degenerate metacone and accessory cusps.

Internal to the lunate main valley, M^1 of C. M. 11935 shows a broad shelf, worn unequally concave, the greatest depth of the concavity being in the posterior portion. The isolated outer portion of the internal fold appears as a pit in an enamel island. On the internal face of the crown, the notch persists nearly to the base of the enamel.

The M^1 of C. M. 11932 shows the same pattern seen in M^1 of the previous specimen, but is less worn and the two portions of the internal fold are not yet separated. M^1 of C. M. 11933 shows a stage of wear intermediate between the stages shown in C. M. 11935 and C. M. 11932; the pit has just been isolated from the internal fold. This tooth also appears to approach nearest the stage of wear shown in the single molar which was collected in the Swift Current Beds in

Saskatchewan and described and figured by Russel.[11] Russel regards this tooth as a probable M^2, but it compares best with M^1 of *Mytonolagus petersoni* m. The pattern in the two specimens is essentially the same; M^1 of C. M. 11933 shows a vertical extent of enamel on the external side of 0.8 mm. and a longitudinal measurement of 1.9 mm., measurements identical with those given for No. 8653 Nat. Mus. of Canada. The transverse measurement of 2.9 mm. given for the Swift Current specimen also compares well with the transverse measurement of 3.1 mm. taken from C. M. No. 11933. Russel has already noted the greater antero-posterior compression of the molar of his specimen over that found in the molar of *Palæolagus haydeni* Leidy. He also states that he has not seen the isolated enamel island and the "crescent" = lunate fold showing together on specimens of *Palæolagus*, but I have some specimens of *Palæolagus haydeni* Leidy showing the condition. However, the condition in this species is preserved for a much shorter time than in *Mytonolagus petersoni* m.

Taking into account the close resemblance which M^1 of the Swift Current specimen bears to the same molar in the Uinta species, and keeping in mind the Uinta character of the Swift Current fauna as a whole, I have little doubt that the Canadian species will prove to be a *Mytonolagus*, perhaps conspecific with *Mytonolagus petersoni* m.

Before passing on to the description of M^2 of this species it might be well to note the interpretation I give the molar structure of *Mytonolagus petersoni* m. I assume that the internal shelf of this species is cingular in origin and probably comprises elements including the protoconule, protocone and hypocone; the anterior "wall" is here considered the protoloph. Regardless of the apparent secondary growth of the internal fold, the fold appears to be connected with, and to have taken its origin at the time of the differentiation of, a hypocone; I see no strong objection to terming the antero-internal portion of the crown the protocone, and the postero-internal portion the hypocone, particularly if it is borne in mind that there may be additional elements represented in the internal shelf. Of the external cusps the metacone is considered to have degenerated, although represented in the external portion of the posterior wall of the crown, while the paracone is still a prominent cusp intervening between the protoloph and the posterior wall, with which it connects in M^1 of this species.

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[11] Russel, L. S. and Wickenden, R. T. D., "An Upper Eocene Vertebrate Fauna from Saskatchewan." Trans. Roy. Soc. Canada, Vol. XXVII, 3rd Series, Sect. 4, pp. 60-61, Pl. 1, fig. 3, 1933.

The above interpretation of the molar cusps of the earlier *Duplicidentata* contrasts with that of Ehik,[12] but appears to me more in accordance with the relationships of the various molar elements in other orders of mammals, and more in keeping with observed evolutionary trends in the cheek teeth of the group itself. It does not require the drastic reversal of topographic relationships of the various cusps which Ehik finds necessary to presuppose in support of his theory of a transverse, rather than a longitudinal arrangement of the principal cusps, with the paracone antero-internal, the hypocone postero-internal, the protocone central and the metacone external. Far from damaging the argument for the premolar analogy theory furnished by the cheek teeth of the *Duplicidentata*, my interpretation really strengthens it, for there does not appear to be any evidence that in the course of molarization of the premolars of this order the anterior horn of the crescentic cusp fuses with the main postero-external cusp, as Ehik supposes. On the other hand, I have observed in the premolars, molars and deciduous teeth of *Palæolagus haydeni* Leidy a progressive degeneration of the postero-external cusp and its accessory cuspules from anterior to posterior teeth in such a clear-cut manner that, regardless of cusp homologies in these series of teeth, I am convinced that the process is essentially the same in each series.

The M^2 of the holotype of *Mytonolagus petersoni* m. is badly worn, but still preserves details of the original pattern. It was exceeded in size by M^1, but not by P^4. As far as I am aware, in the known species of *Palæolagus*, P^4 always exceeds M^2 in size. The paracone in this tooth appears to be connected with the posterior wall. The enamel island with the pit occurs in the internal shelf and the internal notch still persists in this specimen.

The M^2 of C. M. No. 11932 is very little worn and shows nearly every detail of a newly erupted tooth. It is of particular interest because of the transverse arrangement of its paracone, which connects, not with the posterior wall, but with the isthmus connecting the anterior and posterior lobes of the crown. In consequence the posterior valley is elongate and extends farther internally than the anterior valley. A similar transverse arrangement of the paracone and principal valleys is sometimes found in *Palæolagus brachyodon*

[12] Ehik, J., "The Right Interpretation of the Cheekteeth Tubercles of Titanomys." Ann. Mus. Nat. Hungarici, Vol. XXIII, pp. 178-186, figs. 1-5, 1926.

Matthew, not only in M^2, but also in M^1; on the other hand, I have seen the more crescentic type of paracone and short valley occur in M^1 of that species, just as appears to have occurred in M^2 of the holotype of *Mytonolagus petersoni* m. The more transverse type of paracone I have not noted to occur in M^1 and M^2 of species of the *haydeni* group of *Palæolagus*, but as I have stated it is sometimes found in *Palæolagus brachyodon* Matthew and I suspect that it may occur in *Palæolagus turgidus* Cope and *Palæolagus intermedius* Matthew. The species of the *turgidus* group appear to have advanced somewhat beyond those of the *haydeni* group in the pattern of this region, and the degeneration of the metacone and accessory cusps is carried further; *Mytonolagus petersoni* m. shows alliance with the *turgidus* group in this as in other characters.

The M^2 of C. M. 11932 is of further interest in that it shows the hypocone as a fairly distinct cusp, somewhat pinched off from the posterior lobe, and nearer the base of the crown than the protocone. M^2 of C. M. 11933 is slightly more worn than the tooth last mentioned, but shows the same pattern.

The holotype of *Mytonolagus petersoni* m. is the only specimen with which M^3 was found. The tooth, which was found loose, is that of the left side and the root is single, longitudinally compressed but with a strong groove on the posterior face, partly separating it into an external and an internal portion. The outer portion probably represents one, or perhaps two, outer rootlets of the type found on M^1 and M^2. The triturating surface of this tooth shows a transverse paracone between anterior and posterior transverse valleys and a bulbous cuspule-like swelling along the postero-external border. The internal groove still persists on the posterior face of the crown, but the entire posterior lobe is much reduced. In general the tooth rather closely resembles the corresponding molar in *Palæolagus brachyodon* Matthew.

As noted under the description of P^4 of C. M. No. 11932, the latter permanent tooth was concealed by DP^4 which was removed to expose the unerupted tooth. The deciduous tooth, although worn, shows a pattern which approaches that of M^1 of the same specimen. The isolated enamel island and pit, so characteristic of the permanent molars, is shown here in the milk tooth also. The tooth showed two external rootlets.

The lower jaw of the holotype preserves all the cheek teeth and a part of the incisor. As compared with the lower jaw of *Palæolagus* *haydeni* Leidy it is somewhat lighter in construction throughout, and particularly in the inferior portion; it appears nearly as deep as that of the White River species, but is more transversely compressed in the premolar region; the internal side of the ramus is more vertical and less concave. The posterior mental foramen appears beneath P^4, in about the same situation as in *Palæolagus haydeni* Leidy. None of my specimens preserves the anterior mental foramen, the dental foramen, or the masseteric scar. The diastema, as nearly as I can determine from C. M. 11867, which still preserves considerable of the incisor, had about the same extent as in *Palæolagus haydeni* Leidy, but the course of the incisor diverges less from the plane of the ramus. The incisive swelling is less prominent and extends back under M^2, but the incisor does not reach posteriorly beyond the anterior root of the latter tooth. The cheek teeth are larger in proportion to the size of the ramus than in the White River species, and more transverse; the outline of the external border of the tooth row is irregular and more convex.

The lower incisor is more slender than that of *Palæolagus haydeni* Leidy, and does not show the tendency toward a flattened anterior face seen in the White River species.

Seen at the superior surface, P_3 of the holotype shows an outline such as I would expect to find in the much worn P_3 of *Palæolagus brachyodon* Matthew; the anterior lobe still preserves a cylindrical section, while the posterior lobe appears compressed longitudinally, and at the present stage of wear is exceeded in size by the anterior. There is not a trace of an internal reëntrant angle, unless a vague and faint incurvature of the internal margin of the crown can be interpreted as such. The external reëntrant angle extends about half-way across the worn surface of the crown. RP_3 of the holotype, which was found loose, shows the anterior and the posterior root portions conjoined.

Ironically enough, but two of my specimens, the holotype and C. M. No. 11939, preserve P_3 intact, and in both cases the tooth is much worn. However, the P_3 of *Mytonolagus petersoni* m. so closely resembles the corresponding tooth in species of the *turgidus* group of *Palæolagus* that I feel safe in predicting that the less worn tooth of this species, when found, will show a pattern similar to that seen in the species comprising the latter association.

Despite Matthew's[13] stand that *Palæolagus triplex* Cope is probably a synonym for *Palæolagus turgidus* Cope, with which I heartily concur, Walker,[14] in a recent paper gives the impression that *Palæolagus turgidus* Cope lacks internal reëntrants on P_3. This is emphatically not the case. The "trifolium-lobate crown" described by Cope[15] as characteristic of A. M. No. 5630, the type of *Palæolagus triplex* Cope, I have found to characterize all the specimens of P_3 of *Palæolagus turgidus* Cope which I have seen in which the pattern has not been obliterated by wear. Furthermore, in a specimen from the Upper Brule of the Wildcat Range of Nebraska, recently forwarded to me by Mr. R. V. Witter of Bayard, Nebraska, and which I take to be a lower jaw of *Palæolagus intermedius* Matthew, I find the pattern of P_3 to be of the same general type. I have not seen P_3 of *Palæolagus brachyodon* Matthew unworn or in the earlier stages of wear, but I anticipate finding a similar pattern in P_3 of this species.

As a matter of fact, had Walker seen a slightly worn P_3 of *Palæolagus turgidus* Cope he would have distinguished three internal reentrants, one postero-internal, demarking the "third lobe" = hypoconulid, one median-internal marking off the trigonid from the talonid region of the crown, and one antero-internal, subdividing the anterior lobe. All these reëntrants have a short vertical extent on the crown, the median and anterior are slightly more persistent, but all are eliminated at an early stage of wear. On the external side of the crown, I have noted but one persistent reëntrant which marks off the anterior and the posterior lobes, although I suspect that some specimens may show a short postero-external reëntrant.

This is the pattern which will be found, I believe, to characterize P_3 of species of the *turgidus* group of *Palæolagus*, and the pattern showing in P_3 of young individuals of *Mytonolagus petersoni* m. will probably approach this type.

In P_3 of species of the *haydeni* group of *Palæolagus* the most evident departure from the *turgidus* type of pattern is seen on the internal side. In *Palæolagus haydeni* Leidy the reëntrant corresponding to the median internal reëntrant seen in P_3 of *Palæolagus turgidus* Cope not only shows marked persistence, apparently lasting throughout the life of the animal, as Matthew has pointed out,[16] but also appears to differ from the same reëntrant in P_3 of the *turgidus* group in being composed of an inner and an outer portion which are separated by wear, the inner portion being represented by a vertical groove on the internal face of the crown, while the outer part cuts downward into the crown and shows as a pit in an isolated enamel island on the worn superior surface of the tooth. The familiar notch and pit representing the internal fold in the worn superior molars and premolars is the same type of structure.

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[13] Matthew, W. D., "Fossil Mammals of the Tertiary of Northeastern Colorado." Mem. Amer. Mus. Nat. Hist., Vol. I, part VII, p. 377, 1901, and "A Horned Rodent From the Colorado Miocene. With a Revision of the Mylagauli, Beavers, and Hares of the American Tertiary." Bull. Amer. Mus. Nat Hist., Vol. XVI, Art. XXII, p. 309, 1902.

[14] Walker, M. V., "Notes on North American Fossil Lagomorphs." The Ærend, Vol. II, No. 4, p. 234, 1931.

[15] Cope, E. D., Pal. Bull. 16, p. 4, 1873.

On the other hand, not only is the median internal fold much less persistent in P_3 of species of the *turgidus* group in which it has been observed, but the external portion, the deep pit which shows on the worn P_3 of the *haydeni* species association, is either wanting or else but slightly developed. That it may show some slight development in some of these species might be inferred from a study of P_3 of the Upper Brule specimen which I have referred to *Palæolagus intermedius* Matthew; in this tooth there is a cone-shaped depression in the superior surface of the crown external to the internal reëntrant which may correspond to the pit in P_3 of species of the *haydeni* type.

The internal and external reëntrants marking off the "third lobe" in P_3 of *Palæolagus haydeni* Leidy are rather variable in their development, but are usually distinguishable on the unworn tooth.[17] The antero-internal reëntrant in P_3 of *Palæolagus turgidus* Cope may correspond to the anterior valley separating the principal anterior cusps in P_3 of *Palæolagus haydeni* Leidy. This valley is not always distinguishable in the latter species, however. In some specimens of *Palæolagus haydeni* Leidy an additional cuspule is found anterior to the usual two main trigonid cusps, and a few show a faint vertical groove on the external face of the anterior lobe. The latter groove also appears on P_3 of some of Mr. Witter's specimens from the Upper Brule which I have referred to *Palæolagus agapetillus* Matthew (*non* Cope). The groove is a commoner occurrence in the Upper Brule species, though, and when found, is stronger.

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[16] Matthew, W. D., "The Fauna of the Titanotherium Beds of Montana." Bull. Amer. Mus. Nat. Hist., Vol. XIX, Art. VI, p. 217, 1903.

[17] Walker has stressed the presence of a postero-internal reëntrant in P^3 of his proposed genus *Protolagus*. See The Ærend, Vol. II, No. 4, pp. 230-232, Plate I (p. 239), 1931. I believe that variations of this character are not even of specific, let alone of generic, value. For that matter *Protolagus affinus* Walker appears very much like *Palæolagus haydeni* Leidy, judging from Walker's figures and description.

The P_4 of the holotype of *Mytonolagus petersoni* m. is about a third more transverse than P_3 of the same specimen. The internal reëntrant valley is quite persistent in P_4 and in the molars of this species, and the base of it appears to be indicated in this specimen. A similar vertical extent of this fold is shown in P_4 of C. M. 11935, and in other specimens. LP_4 of C. M. 11939 shows a superior surface worn close to the base of the external fold. Internal to the main transverse fold occurs a small isolated pit, reminiscent of that seen in the worn P_3 of *Palæolagus haydeni* Leidy. RP_4 of the holotype shows two roots, arranged antero-posteriorly. The disproportion in size between M_1 and P_4 of *Mytonolagus petersoni* m. seems greater than that usually seen in species of *Palæolagus*. Although worn in the holotype, M_1 is considerably less so in C. M. No. 11935; in the last specimen the postero-internal reëntrant marking off the third lobe is still preserved. The main internal reëntrant is less persistent than in P_4. The shattered and but little worn M_1 of C. M. No. 11867 shows the hypoconulid as a prominent lobe. At this stage of wear the hypoconulid shows as a strong lobe and the postero-external reëntrant is a prominent notch. RM_1 of the holotype shows two root portions, separate below. The anterior portion shows two canals, the posterior, one.

In the holotype of *Mytonolagus petersoni* m., M_2 presents practically the same construction as M_1. These teeth accord rather closely in dimensions, both transverse and longitudinal. Grooves on the single root of RM_2 still indicate its tri-fanged origin.

I have M_3 in but one specimen, the holotype. The tooth is larger than in any of the species of *Palæolagus*, and shows a faint trace of the external reëntrant on the outer face of the crown, internal to which there shows an isolated enamel island. The tooth seems to have but one root.

The DP_3 is present in a badly shattered condition in C. M. No. 11867. In its present state it is hazardous to attempt an interpretation of its original construction. In general, it resembles the corresponding tooth in *Palæolagus haydeni* Leidy. The tooth is double-rooted.

The same specimen retains DP_4. The tooth resembles DP_4 in *Palæolagus haydeni* Leidy, and shows a prominent third lobe, together with a persistent external reëntrant. Antero-internally a notch appears on the anterior lobe of this tooth. Two roots are present as in DP_3.

The skeletal material recovered with C. M. No. 11935 indicates an animal of somewhat lighter frame than *Palæolagus haydeni* Leidy. The head of the humerus is less globular than in the latter species, but stands higher than the greater tuberosity. Distally the entepicondylar foramen and general proportions appear to be much as in *Palæolagus haydeni* Leidy, but the radial articular surface is less convex. The proximal portion of the tibia generally resembles that of *Palæolagus haydeni* Leidy. A portion of the shaft of this bone shows its fusion with the fibula.

Discussion: In the way of clues to the relationships of the *Duplicidentata* and other orders of mammals, or to the origin of the group, *Mytonolagus* shows little more than might be gained from a study of *Palæolagus.* Its chief interest lies in the fact that it gives us an Upper Eocene stage in the evolution of the order, although the latter might well have been inferred from Matthew's[18] observations on developmental trends in *Palæolagus*; most of the modifications traceable in the Oligocene genus are already foreshadowed in *Mytonolagus.* The specialization found in the present species will come as no surprise to students familiar with the Oligocene tendencies seen in the more progressive elements of the Uinta fauna.

The Uinta form finds a near ally in the Pipestone Creek species *Palæolagus brachyodon* Matthew. Its affinities as a whole are with *Palæolagus brachyodon* Matthew, *Palæolagus turgidus* Cope, and *Palæolagus intermedius* Matthew, rather than with the species of the *haydeni* assemblage. Walker's[19] proposal to separate *Palæolagus turgidus* Cope under the generic name *Megalagus* was premature, and his genus at best rests upon a rather insecure footing as he has diagnosed it. However, the species of the *turgidus* group show characters in common which seem to demand their recognition as a distinct line, and if further study demonstrates that they form a unit without close intergradations with species of the *haydeni* type, Walker's genus should be given full recognition and extended to include *Palæolagus brachyodon* Matthew and *Palæolagus intermedius* Matthew.

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[18] Matthew, W. D., "Fauna of the Titanotherium Beds of Montana." Bull. Amer. Mus. Nat. Hist., Vol. XIX, Art. VI, p. 218, 1903.

[19] Walker, M. V., "Notes on North American Fossil Lagomorphs." The Ærend, Vol. II, No. 4, pp. 234-235, 1931.

Mytonolagus petersoni m. and species of the *turgidus* type of *Palæolagus* bear considerable resemblance to *Desmatolagus* from the Oligocene of Mongolia. I consider the latter an aberrant genus of the *Leporidæ*, in which family it was first placed by Matthew and Granger;[20] if it is to be regarded as an ancestral Ochotonid these North American species are close to the same category. It is true, though, that these American species also show closer similarity to *Titanomys* of the European Oligocene and Miocene than does *Palæolagus haydeni* Leidy, which Forsyth Major[21] selected for comparison with the European form. There can be no doubt that *Mytonolagus* is near the stem stock from which both the *Leporidæ* and the *Ochotonidæ* diverged, and in many respects can be taken as structurally ancestral to both families. However, a great deal of comparative study is required before any confident statements can be made as to the interrelationships of the various earlier genera which have been referred to the *Leporidæ* and to the *Ochotonidæ*.

MEASUREMENTS

Carnegie Museum No. 11937 (Holotype).

	mm.
P^2 antero-posterior (triturating surface)	1.5
P^2 transverse (external border to inner edge of triturating surface)	2.0
P^2 transverse (external border to inner alveolar margin)	2.7
P^3 antero-posterior (triturating surface)	1.9
P^3 transverse (external border to inner edge of triturating surface)	3.9
P^3 transverse (external border to inner alveolar margin)	5.0
P^4 antero-posterior (triturating surface)	1.9
P^4 transverse (external border to inner edge of triturating surface)	4.8
P^4 transverse (external border to inner alveolar margin)	6.2
M^1 antero-posterior (triturating surface)	2.1
M^1 transverse (external border to inner edge of triturating surface)	5.8*
M^1 transverse (external border to inner alveolar margin)	6.8*
M^2 antero-posterior (triturating surface)	1.9
M^2 transverse (external border to inner edge of triturating surface)	4.5
M^2 transverse (external border to inner alveolar margin)	6.3
M^3 antero-posterior (triturating surface)	1.5
M^3 transverse (external border to inner edge of triturating surface)	2.3
M^3 greatest transverse at right angles to long axis of tooth	2.7

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[20] Matthew, W. D. and Granger, Walter, "Nine New Rodents from the Oliogcene of Mongolia." Amer. Mus. Novitates, No. 102, pp. 8-10, figs. 10-12, Dec. 31, 1923.

[21] Major, C. J. Forsyth, "On Fossil and Recent Lagomorpha." Trans. Linn. Soc. Lond., Ser. 2, Vol. VII, pp. 470-472, Pl. 36, fig. 36, 1899.

	mm.
Length of superior premolar series (at triturating surface)	5.8
Length of superior molar series (at triturating surface)	5.5**
Maxillary tooth row, alveolar measurement	11.5**
Inferior I, antero-posterior	2.4***
Inferior I, transverse	1.4***
P_3 antero-posterior (triturating surface)	1.9
P_3 transverse (triturating surface)	1.5
P_3 transverse (at alveolus)	1.7
P_4 antero-posterior (triturating surface)	2.0
P_4 transverse (triturating surface)	2.3
P_4 transverse (at alveolus)	2.3
M_1 antero-posterior (triturating surface)	2.3
M_1 transverse (triturating surface)	2.5
M_1 transverse (at alveolus)	2.8
M_2 antero-posterior (triturating surface)	2.4
M_2 transverse (triturating surface)	2.5
M_2 transverse (at alveolus)	2.7
M_3 antero-posterior (triturating surface)	1.9
M_3 transverse (triturating surface)	1.5
M_3 transverse (at alveolus)	1.6
Length of inferior premolar series (triturating surface)	4.1
Length of inferior premolar series (at alveoli)	4.9
Length of inferior molar series (triturating surface)	6.8
Length of inferior molar series (at alveoli)	7.4
Length mandibular tooth row (triturating surfaces)	10.4
Length mandibular tooth row (at alveolus)	12.4
Depth ramus under M_1 (to base of incisive swelling, internal measurement)	7.2
Width superior portion of ramus below M_1	4.9
Width superior portion of ramus below P_4	3.4
Width superior portion of ramus below P_3	2.7

Carnegie Museum No. 11935 (Paratype).

	mm.
P^3 antero-posterior (triturating surface)	1.7
P^3 transverse (external border to inner edge of triturating surface)	3.0
P^3 greatest transverse at right angles to long axis of tooth	3.8
P^4 antero-posterior (triturating surface)	2.0
P^4 transverse (external border to inner edge of triturating surface)	3.3
P^4 greatest transverse at right angles to long axis of tooth	4.4
M^1 antero-posterior (triturating surface)	2.1
M^1 transverse (external border to inner edge of triturating surface)	4.0
M^1 greatest transverse at right angles to long axis of tooth	5.0*
Inferior I antero-posterior	2.4***
Inferior I transverse	1.4***
P_3 antero-posterior (at alveolus)	2.5

	mm.
P_3 transverse (at alveolus)	1.5
P_4 antero-posterior (triturating surface)	2.2
P_4 transverse (triturating surface)	2.0
P_4 transverse (at alveolus)	2.6
M_1 antero-posterior (triturating surface)	2.3
M_1 transverse (triturating surface)	2.5
M_1 transverse (at alveolus)	2.8
Humerus, proximal portion, antero-posterior	5.2
Humerus, proximal portion, transverse	7.2
Humerus, at entepicondylar foramen, antero-posterior	2.4
Humerus, at capitellum, antero-posterior	3.0
Tibia, proximal portion, antero-posterior	7.6
Tibia, proximal portion, transverse	8.5
Tibia, distal portion of shaft, antero-posterior	2.4
Tibia, distal portion of shaft, transverse	3.0

Carnegie Museum No. 11932 (Paratype).

	mm.
P^3 antero-posterior (unworn crown surface)	1.6
P^3 transverse (unworn crown surface)	2.9
P^4 antero-posterior (unworn crown surface)	2.4
P^4 transverse (unworn crown surface)	2.9
M^1 antero-posterior (triturating surface)	1.9
M^1 transverse (external border to inner edge of triturating surface)	3.0
M^1 transverse (external border to inner alveolar margin)	4.8
M^2 antero-posterior (triturating surface)	1.9
M^2 transverse (external border to inner edge triturating surface)	2.5
M^2 transverse (external border to inner alveolar margin)	4.0
DP^4 antero-posterior (triturating surface)	2.2**
DP^4 transverse (external border to inner edge triturating surface)	3.0

Carnegie Museum No. 11940.

	mm.
I^2 antero-posterior	1.7
I^2 transverse	1.8
Inferior I antero-posterior	2.0
Inferior I transverse	1.6

Carnegie Museum No. 11933.

	mm.
M^1 antero-posterior (triturating surface)	1.9
M^1 transverse (external border to inner edge triturating surface)	3.1
M^1 transverse (external border to inner alveolar margin)	4.7
M^2 antero-posterior (triturating surface)	1.9
M^2 transverse (external border to inner edge triturating surface)	2.8
M^2 transverse (external border to inner alveolar margin)	3.9

Carnegie Museum No. 11867.

	mm.
Inferior I (antero-posterior)	1.6
Inferior I (transverse)	1.6
Length of diastema	8.3*
DP$_3$ antero-posterior (triturating surface)	2.5**
DP$_4$ antero-posterior (triturating surface)	2.9
DP$_4$ transverse (external border to inner edge triturating surface)	2.0
M$_1$ antero-posterior (triturating surface)	2.5
DP$_3$—DP$_4$ length at alveolus	4.4

Carnegie Museum No. 11939.

Inferior I antero-posterior	1.7
Inferior I transverse	1.7
P$_3$ antero-posterior (triturating surface)	1.7
P$_3$ transverse (triturating surface)	1.6
P$_3$ transverse at alveolus	1.7
P$_4$ antero-posterior (triturating surface)	2.3
P$_4$ transverse (triturating surface)	2.2
P$_4$ transverse at alveolus	2.7
M$_2$ antero-posterior (triturating surface)	2.6
M$_2$ transverse (triturating surface)	2.6*
M$_2$ transverse at alveolus	3.4
Depth of ramus under M$_1$ internal measurement	7.9
Width superior portion of ramus below M$_1$	3.6
Width superior portion of ramus below P$_4$	3.5
Width superior portion of ramus below P$_3$	3.0
Length of inferior premolar series (triturating surface)	4.2
Length of inferior premolar series (at alveoli)	4.8
Length of inferior molar series (at alveoli)	7.8*
Length of mandibular tooth row (triturating surfaces)	10.8*
Length of mandibular tooth row (at alveoli)	12.0

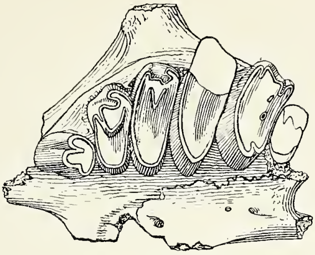
*Estimated.

**Approximate.

***Crushed.

EXPLANATION OF FIGURES

1. *Mytonolagus petersoni* Burke, holotype, C. M. No. 11937, lower aspect of maxillary with P^2—M^2 left, LM^1 restored in outline, LM^3 represented in outline by RM^3 reversed, × 3.
2. *Mytonolagus petersoni* Burke, holotype, C. M. No. 11937, RM^3, occlusal view, × 3.
3. *Mytonolagus petersoni* Burke, holotype, C. M. No. 11937, P_4—M_3 left, occlusal view, × 3.
4. *Mytonolagus petersoni* Burke, holotype, C. M. No. 11937, left ramus of mandible, outer surface, × 3.
5. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11932, lower aspect of maxillary with P^3—M^2 left, × 3.
6. *Mytonolagus petersoni* Burke, paratype, C. M. 11932, occlusal view of LDP^4, × 3.
7. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11935, left humerus, proximal portion, outer aspect, × 3.
8. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11935, left humerus, distal portion, anterior aspect, × 3.
9. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11935, right tibia, proximal end, × 3.
10. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11935, P^3—M^1 right, occlusal view, × 3.
11. *Mytonolagus petersoni* Burke, paratype, C. M. No. 11935, P_3 (broken at alveolus) P_4 and M_1 left, slightly oblique occlusal view, × 3.
12. *Mytonolagus petersoni* Burke, C. M. No. 11940, RI^2, anterior view, × 3.
13. *Mytonolagus petersoni* Burke, C. M. No. 11940, RI^2, occlusal view, × 3.



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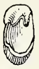

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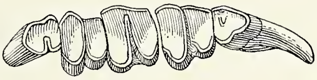

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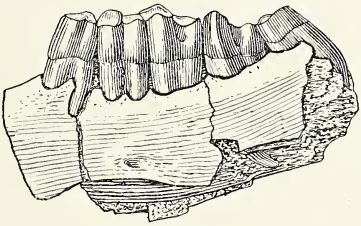

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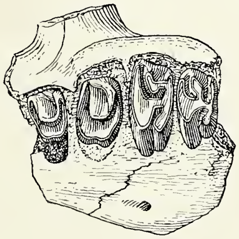

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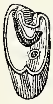

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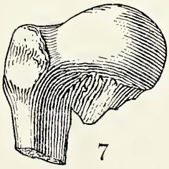

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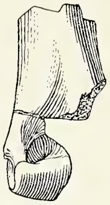

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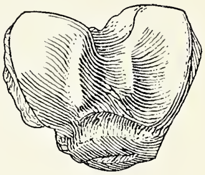

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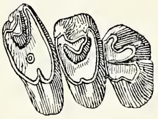

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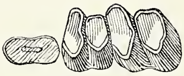

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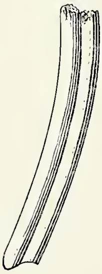

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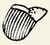

13

INDEX

aalge, Uria, 58
Abies concolor, 249
Acacia greggii, 246
Acanthis hornemanni, 73
    linaria, 74
Acer interior, 249
Actitis macularia, 37
acuminata, Alnus, 249
acuta, Dafila, 18
Adjidaumo douglassi, 395
aduncus, Limnogonus, 209, 236
aestiva, Dendroica, 69
affinis, Bulimina, 306
    Nyroca, 21
Agave, 249
    palmeri, 247, 248
    schottii, 247
alacris, Gerris, 192, 232
alba, Crocethia, 48
albeola, Charitonetta, 22
albicollis, Zonotrichia, 79
albifrons, Anser, 16
    Petrochelidon, 64
albigula albigula, Neotoma, 265
alcyon, Megaceryle, 62
Allen, Mrs. T. R., 88
alleni, Lepus alleni, 256, 267
Alnus acuminata, 249
alpestris, Otocoris, 63
alpina, Pelidna, 43
alticuspidens, Protictops, 361, 374
amalgamata, Heteropora, 288
americana, Grus, 31
    Jamesia, 249
    Mareca, 18
    Oidemia, 24
Ammospermophilus harrisii, 263
    harrisii, 256, 270, 271
    saxicola, 271
Amphistegina hauerina, 321
Amphistegina lessoni, 318
Anas platyrhynchos, 17
    rubripes, 17
Andropogon scoparium, 247
angulatus sonoriensis, Pecari, 269
Anisonyx (Ammospermophilus) harrisii, 256
    (Ictidomys) tereticaudus, 255
    (Otospermophilus) grammurus, 253
Annotated List of Mammals, 251
Anser albifrons, 16
Antelope Jack Rabbit, 267
Anthus spinoletta, 68
antillarum, Eponides, 313
antioguiensis, Siphonina, 316
Aquila chrysaëtos, 27
aquilina, Pteris, 249
arborea, Spizella, 78
Arbutus arizonica, 248, 249
arctica, Gavia, 11
Arctostaphylos pungens, 247, 248
Arenaria interpres, 35
argentatus, Larus, 52
argenticollis, Gerris, 196, 232
Arizona Cottontail, 269
    Jack Rabbit, 267
    Porcupine, 266
Arizona—Vegetation, 244
    Desert region, 245, 246
    Encinal region, 245, 248
    Forest region, 245, 248
    Life zones: Lower Sonoran, Upper Sonoran, Transition, Canadian, 245
arizonæ, Citellus tereticaudus, 255
    Lepus sylvaticus, 269
    Sylvilagus audubonii, 269
arizonica, Arbutus, 248, 249
    Pinus, 249
arizonensis, Sciurus, 270

arizonensis, Sciurus, arizonensis, 244, 260
    catalinæ, Sciurus, 260
Asclepias linifolia, 247
Ash, 247
Asio flammeus, 61
Asperrimum, Galium, 249
Asterias huntleyi, 289
Astur atricapillus, 26
Atalapha borealis, 251
atrata, Cytherella, 283
atratiensis, Cibicides, 338
    Discorbis, 310
atricapillus, Astur, 26
Avinoff, A., 241
auberiana, Quinqueloculina, 295
audubonii arizonæ, Sylvilagus, 269
auratus, Colaptes, 62
auritus, Colymbus, 13

Baccharis sarothroides, 246
baileyi baileyi, Perognathus, 262
Bailey Pocket Mouse, 262
bairdi, Pisobia, 42
Bajada, Upper—Lower, 246
Banks, Dr. Nathan, 181
Barber, H. G., 181
Barrel Cactus, 246
Bartramia longicauda, 37
Batamote, 246
Bathysiphon, 291
Bear Canyon, 242
Bear Grass, 247
Beard Grass, 247
Beier, Dr. Max, 181
beieri, Gerris, 200
Bell, Robert, 2
Bibliography (Arizona Mammals), 271-274
bicolor, Iridoprocne, 64
bidentatus, Potamobates, 227, 240
bigelovii, Solidago, 249
Birds of Churchill, Manitoba.
    P. A. Taverner and G. M. Sutton, 1-83
biuncifera, Mimosa, 248
Bombycilla garrula, 68
borealis, Atalapha, 251
    Buteo, 26
    Lanius, 69
    Phaeopus, 37
Botaurus lentiginosus, 13
Bouteloua rothrockii, 247
boylii rowleyi, Peromyscus, 265
brachyodon, Palœolagus, 402
brachyrhynchos, Corvus, 65
bradii, Planulina, 333
Bradley, Dr. J. C., 181
Brake Fern, 249
Branta canadensis, 15
Bubo virginianus, 59
buccinator, Cygnus, 14
buenoi, Gerris, 195, 232
Bulimina affinis, 306
Buliminella pulchra, 305
bulloides, Globigerina, 322
Bunch Grass, 249
Burke, J. J., 391, 399
Burt, W. H., 250
Buteo borealis, 26
    lagopus, 26

Cactus, Giant, 246
Cactuses, 246
Calcarius lapponicus, 80
    pictus, 80
calendula, Corthylio, 67
Calidris canutus, 40
California Academy of Sciences, 241
californica, Simmondsia, 246
    Vaquelinia, 247
californicus eremicus, Lepus, 267, 271
Canachites canadensis, 30
canadensis, Branta, 15
    Grus, 32
    Perisoreus, 64
    Sitta, 66
canaliculatus, Gerris, 187, 236
Canis mearnsi, 270
canutus, Calidris, 40
Canyon Spotted Skunk, 252
Capella delicata, 35
cariniventris, Gerris, 197, 236

carmelus, Gerris, 201, 238
Carnegiea gigantea, 246, 247
carolina, Porzana, 32
carolinense, Nettion, 19
carolinensis, Sitta, 66
carolinus, Euphagus, 72
caspia, Hydroprogne, 58
Castilleja gloriosa, 249
catalinæ, Thomomys fulvus, 261
Cat Claw, 246
  Mountain, 242
Catoptrophorus semipalmatus, 39
Ceanothus fendleri, 249
celata, Vermivora, 69
celeris, Limnogonus, 214, 238
celocis, Tenagogonus, 218, 236
Celtis reticulata, 246
cembroides, Pinus, 248
Cepphus grylle, 59
Charadrius semipalmatus, 33
Charitonetta albeola, 22
Chaulelasmus streperus, 18
Check-List of Mammals, 250
Chen hyperborea, 16
  rossi, 14
Chihuahua Pine, 248
chihuahuana, Pinus, 248
chilensis, Gerris, 187
Chilopsis linearis, 246
China, W. E., 181
Chincha estor, 252
Chiridota, 291
Chlidonias nigra, 58
chocoiensis, Siphonina, 317
Chordeiles minor, 62
chrysaëtos, Aquila, 27
Chrysoma laricifolia, 247
Cibicides atratiensis, 338
  colombianus, 337
  concavus, 339
  depressus, 338
  mckannai, 336
  nephridium, 340
  pseudoungerianus, 335
  risseri, 335
Circus hudsonius, 27
Citellus neglectus, 255
  tereticaudus arizonæ, 255
    neglectus, 255, 270
    tereticaudus, 255
clangula, Glaucionetta, 21
Clangula hyemalis, 22
Clapp, Dr. George H., 357
Cliff Chipmunk, 259
clypeata, Spatula, 20
Colaptes auratus, 62
colombiana, Lenticulina, 300
colombianum, Lithothamnium, 343
colombianus, Cibicides, 337
Colorado Rock Squirrel, 253
columbarius, Falco, 29
columbianus, Cygnus, 14
Colymbus auritus, 13
comatus, Gerris, 193, 232
  mickeli, Gerris, 193
concavus, Cibicides, 339
concolor, Abies, 249
  azteca, Felis, 270
conformis, Gerris, 185, 234
conglobata, Globigerinoides, 331
conglomerata, Globigerina, 329
Cook, Harold, 400
corax, Corvus, 65
coronata, Dendroica, 70
Corthylio calendula, 67
Corvus brachyrhynchos, 65
  corax, 65
Coturnicops noveboracensis, 33
couesi, Erethizon epixanthum, 271
  Odocoileus, 270
Coyote, 270
Creosote Bush, 246
crispum, Elphidium, 304
cristata, Cyanocitta, 64
crocea, Rhamnus, 248
Crocethia alba, 48
cucullatus, Lophodytes, 25
Cyanocitta cristata, 64
Cygnus buccinator, 14
  columbianus, 14
Cylindrostethus erythropus, 219, 238
  hungerfordi, 221

Cylindrostethus linearis, 220, 238
    palmaris, 222
    regulus, 222, 238
Cytherella atrata, 283

Dafila acuta, 18
Dalea wislizeni, 247
Dasylirion wheeleri, 247
Deer, 270
deglandi, Melanitta, 24
delawarensis, Larus, 55
delicata, Capella, 35
Dendroica aestiva, 69
    coronata, 70
    palmarum, 70
    striata, 70
Dentalina pauperata, 302
depressus, Cibicides, 338
Desert Arroyos and Canyons, 246
    Laboratory, Tumanoc Hill, 242
    Region, 246
Desmatolagus gobiensis, 402
Dipodomys merriami merriami, 263
    spectabilis spectabilis, 262
Discorbis atratiensis, 310
    floridensis, 310
discors, Querquedula, 20
dissortis, Gerris, 188, 230, 234
Dolans Spring Ground Squirrel, 255
domesticus, Passer, 72
dominica, Pluvialis, 34
dorsalis dorsalis, Eutamias, 259
    Junco phœonotus, 244
    Tamias, 259
Douglas Fir, 249
douglassi, Adjidaumo, 395
Doutt, J. Kenneth, 241
Drake, C. J., 179
Drake, Edward, 88, 92
Dryobates villosus, 62
Duchesne River Oligocene, List of Species and Description of new Material from, 373-389
dumosa, Muhlenbergia, 247
dutertrei, Globigerina, 328

Echinocereus polycanthos, 249
Elegans, Planulina, 334
Eliot, Mather, 357
Eller, E. R., 275
elliptica, Heteropora, 287
Elphidium crispum, 304
emoryi, Quercus, 248
enucleator, Pinicola, 73
Epitriplopus medius, 361, 387
epixanthum couesi, Erethizon, 266
Eponides antillarum, 313
    limbatus, 315
    praecinctus, 314
eremicus, Lepus californicus, 256
    texianus, 267
Erethizon epixanthum couesi, 266
Ereunetes pusillus, 46
Erigeron neomexicanus, 249
    wrightii, 247
erythropus, Cylindrostethus, 219, 238
estor, Chincha, 252
    Mephitis, 252
Euphagus carolinus, 72
Eutamias dorsalis dorsalis, 259
exigua, Salix, 249
Extopistes migratorius, 59

Falco columbarius, 29
    peregrinus, 28
    rusticolus, 28
    sparverius, 29
Felis concolor azteca, 270
fendleri, Ceanothus, 249
Ferocactus wislizeni, 246
flammeus, Asio, 61
flavipes, Totanus, 40
flavolineatus, Gerris, 197, 236
Florida Canyon, 242
floridensis, Discorbis, 310
formosum, Hypericum, 249
Fouquieria splendens, 246
fragilis, Spermites, 341
Fraxinus toumeyi, 247
Frick, Childs, 357
Fuehrer, Ludwig, 242
Fuehrer, Mr. and Mrs. Ottmar, 242

fulicarius, Phalaropus, 49
fulvus intermedius, Thomomys, 261
fuscicollis, Pisobia, 41
fuscinervis, Gerris, 198
fusiformis, Verneuilina, 291

Galium asperrimum, 249
garrula, Bombycilla, 68
Garrya wrightii, 248
Gavia arctica, 11
    immer, 10
    stellata, 12
genticus, Limnogonus, 213
Geography and Chorography, 243
georgiana, Melospiza, 80
Geothlypis trichas, 71
Gerrinae, Key to, 181
Gerrinae of the Western Hemisphere (Hemiptera), By C. J. Drake and H. M. Harris, 179-240
Gerris alacris, 192, 232
    argenticollis, 196, 232
    beieri, 200
    buenoi, 195, 232
    canaliculatus, 187, 236
    cariniventris, 197, 236
    carmelus, 201, 238
    Chilensis, 187
    comatus, 193, 232
        mickeli, 193
    conformis, 185, 234
    dissortis, 188, 230, 234
    flavolineatus, 197, 236
    fuscinervis, 198
    gillettei, 194, 232
    incognitus, 193, 232
    incurvatus, 192, 232
    insperatus, 190, 232
    kahli, 199
    marginatus, 191, 232
    mexicanus, 196
    nebularis, 186, 234
    notabilis, 189, 232
    nyctalis, 190, 234
    pingreensis, 194, 232
    remigis, 189, 234
Gerris summatis, 201
    uhleri, 186, 234
gigantea, Carnegiea, 246, 247
gillettei, Gerris, 194, 232
Glaucionetta clangula, 21
Globigerina bulloides, 322
    conglobata, 331
    conglomerata, 329
    dutertrei, 328
    tricamerata, 324
    trilocularis, 326
gloriosa, Castilleja, 249
gobiensis, Desmatolagus, 402
Golden Rod, 249
Goldman, E. A., 250
Gould, Victor E., 3
gracilis gracilis, Spilogale, 252
Graham, E. H., 242
Graham, H. W., 242
Grama Grass, 247
grammurus, Anisonyx (Otospermophilus), 253
    Otospermophilus grammurus, 244, 253, 270
Granger, Dr. Walter, 400
greggii, Acacia, 246
Grinnell, Dr. Joseph, 241
griseus, Limnodromus, 44
Grus americana, 31
    canadensis, 32
grylle, Cepphus, 59
guerini, Limnogonus, 206, 236
Gyroidina soldanii, 311

Hackberry, Western, 246
haemastica, Limosa, 47
Haliaeetus leucocephalus, 27
haliaetus, Pandion, 28
Hall, Dr. E. Raymond, 241
Hall, E. R., 250
Hamilton, Nellie R., 88
Hamilton, W. J., Jr., 85
Harris Ground Squirrel, 256
Harris, H. M., 179
harrisii, Ammospermophilus, 263

harrisii, Ammospermophilus harrisii, 256, 270
    saxicola, Ammospermophilus harrisii, 257, 271
hauerina, Amphistegina, 321
haydeni, Palæolagus, 401
Hedgehog Cereus, 249
Helohyus, 375
hesione, Limnogonus, 211, 236
Heteropora amalgamata, 288
    elliptica, 287
himantopus, Micropalama, 45
hornemanni, Acanthis, 73
horvathi, Potamobates, 226, 240
Houstonia wrightii, 249
huachuca, Sciurus arizonensis, 260
hudsonicus, Penthestes, 65
    Phaeopus, 36
hudsonius, Circus, 27
Huey, L. M., 250
Hungerford, Dr. H. B., 181
hungerfordi, Cylindrostethus, 221
Huntley, L. G., 275
huntleyi, Asterias, 289
hyalinus, Limnogonus, 208, 238
Hydrobia, 287
Hydroprogne caspia, 58
hyemalis, Clangula, 22
    Junco, 75
Hylocichla minima, 66
hyperborea, Chen, 16
hyperboreus, Larus, 52
Hypericum formosum, 249
Hyracodon primus, 361, 388

ignotus, Limnogonus, 205
iliaca, Passerella, 79
immer, Gavia, 10
incognitus, Gerris, 193, 232
incurvatus, Gerris, 192, 232
insperatus, Gerris, 190, 232
interior, Acer, 249
interpres, Arenaria, 35
Iridoprocne bicolor, 64
isthmi, Lithothamnium, 343
Itinerary (Arizona), 241

Jajobe, 246
Jamesia americana, 249
Janson, Mr. A. R., 181
Jennings, Dr. O. E., 241
Juglans major, 247
    rupestris, 249
Junco hyemalis, 75
    phœonotus palliatus, 244

Kahl, Dr. Hugo, 181
kahli, Gerris, 199
Kay, J. LeRoy, 357
kayi, Leptotomus, 362, 391
Key to Cylindrostethus, 219
    Gerrinae, 181
    Limnogonus, 203
    Potamobates, 224
    Tenagogonus, 216
Kit Fox, 269
kumlieni, Larus, 53

lagopus, Buteo, 26, 30
    Lagopus, 30, 31
Lagopus lagopus, 30
    rupestris, 31
Lanius borealis, 69
lapponicus, Calcarius, 80
Large Kangaroo Rat, 262
laricifolia, Chrysoma, 247
Larrea tridentata, 246
Larus argentatus, 52
    delawarensis, 55
    hyperboreus, 52
    kumlieni, 53
    philadelphia, 55
Lasiurus borealis teliotis, 251
lenticularis, Robulus, 302
Lenticulina colombiana, 300
    lens, 300
    multiseptae, 301
    orbicularis, 301
    rotulata, 297
lentiginosus, Botaurus, 13
lepida stephensi, Neotoma, 266
Leptomeryx minutus, 361, 386
Leptotomus kayi, 362, 391

Lepus alleni alleni, 256, 267
  californicus eremicus, 256, 267, 271
  sylvaticus arizonæ, 269
  texianus eremicus, 267
lessoni, Amphistegina, 318
leucocephalus, Haliaeetus, 27
leucophrys, Zonotrichia, 77
leucoptera, Loxia, 75
Life History of the Rufescent Woodchuck. By W. J. Hamilton, Jr., 85-178
limbatus, Eponides, 315
Limnodromus griseus, 44
Limnogonus aduncus, 209, 236
  celeris, 214, 238
  genticus, 213
  guerini, 206, 236
  hesione, 211, 236
  hyalinus, 208, 238
  ignotus, 205
  lotus, 213
  lubricus, 212
  profugus, 209
  recens, 207, 238
  recurvus, 210, 236
  visendus, 215
Limnogonus, Key to, 203
Limosa haemastica, 47
linaria, Acanthis, 74
lincolni, Melospiza, 79
linearis, Chilopsis, 246
  Cylindrostethus, 220, 238
linifolia, Asclepias, 247
Lithothamnium colombianum, 343
  isthmi, 343
Lloyd, A. C., 3
lobatus, Lobipes, 49
Lobipes lobatus, 49
lomvia, Uria, 58
longicauda, Bartramia, 37
longicaudus, Stercorarius, 52
Lophodytes cucullatus, 25
lotus, Limnogonus, 213
Loxia leucoptera, 75
lubricus, Limnogonus, 212
macrocarpa, Yucca, 247, 248
macrotis neomexicana, Vulpes, 269
macroura, Zenaidura, 59
macularia, Actitis, 37
major, Juglans, 247
maniculatus rufinus, Peromyscus, 263
Manzanita, 247
Mareca americana, 18
marginatus, Gerris, 191, 232
marila, Nyroca, 20
Marmota monax, 87
Matheson, Dr. Robert, 88
mckannai, Cibicides, 336
mearnsi, Canis, 270
medius, Epitriplopus, 361
Megaceryle alcyon, 62
Melanitta deglandi, 24
  perspicillata, 24
melanoleucus, Totanus, 39
melanotos, Pisobia, 40
Melospiza georgiana, 80
  lincolni, 79
Mephitis estor, 252
Mergus serrator, 25
Merriam Kangaroo Rat, 263
merriami merriami, Dipodomys, 263
Mesagriochœrus primus, 361, 377
Mesquite, 246
metcalfii, Oxalis, 249
Mexican Badger, 253
  Pinyon, 248
  White Pine, 249
mexicana bullata, Neotoma, 265
  Sambucus, 247
mexicanus, Gerris, 196
microcarpa, Nolina, 247
Micropalama himantopus, 45
microphylla, Parkinsonia, 246
migratorius, Extopistes, 59
  Turdus, 66
Milkweed, 247
Mimosa biuncifera, 248
  pallida, 246
minima, Hylocichla, 66
minor, Chordeiles, 62
  Paradjidaumo, 396

minutilla, Pisobia, 42
minutus, Leptomeryx, 361, 386
Miocene Microfauna and Flora from the Atrato River, Colombia, South America, 275-356
mollissima, Somateria, 23
monax, Marmota, 87
Mountain Lion, 270
Mountain-top Pocket Gopher, 261
mucronata, Pseudotsuga, 249
Muhlenbergia dumosa, 247
    virescens, 249
Munk, Jens, 1
Museum of Vertebrate Zoology, 241
Mytonolagus petersoni, 362, 400, 402
Mytonolagus, A New Leporine genus from the Uinta Eocene series in Utah, 399-420

nasutus, Paradjidaumo, 396
Natica, 286
nebularis, Gerris, 186, 234
neglecta, Sturnella, 72
neglectus, Citellus, 255
    Citellus tereticaudus, 270
    Spermophilus, 255
Neotoma albigula albigula, 265
    lepida stephensi, 266
    mexicana bullata, 265
nephridium, Cibicides, 340
Nettion carolinense, 19
nigra, Chlidonias, 58
nivalis, Plectrophenax, 81
Nolina microcarpa, 247
notabilis, Gerris, 189, 234
noveboracensis, Coturnicops, 33
    Seiurus, 70
nuda, Osmorrhiza, 249
nyctalis, Gerris, 190, 234
Nyctea nyctea, 60
Nycteris borealis teliotis, 251
Nyroca affinis, 21
    marila, 20

obliquiloculata, Pulleniatina, 332
obscurus, Perognathus, 262
Ocotillo, 246
Odocoileus couesi, 270
Oidemia americana, 24
Old Baldy Peak, 242
opacus, Tenagogonus, 217, 236
Opuntia, 246
Oracle, 243
osborni, Potamobates, 225, 238
Osmorrhiza nuda, 249
Otocoris alpestris, 63
Otospermophilus grammurus grammurus, 244, 253, 270
Oxalis metcalfii, 249
Oxyechus vociferus, 33

palliatus, Junco phœonotus, 244
pallida, Mimosa, 246
palmaris, Cylindrostethus, 222
palmarum, Dendroica, 70
palmeri, Agave, 247, 248
Palœolagus brachyodon, 402
    haydeni, 401
    turgidus, 403
Palo Verde, 246
Pandion haliaëtus, 28
paradisaea, Sterna, 56
Paradjidaumo minor, 396
    nasutus, 396
parasiticus, Stercorarius, 51
Parkinsonia microphylla, 246
    torreyana, 246
Passerculus sandwichensis, 75
Passer domesticus, 72
Passerella iliaca, 79
pauperata, Dentalina, 302
Pecari angulatus sonoriensis, 269
Pelidna alpina, 43
penicillatus pricei, Perognathus, 262
Penthestes hudsonicus, 65
Peppersauce Canyon, 242
peregrina, Vermivora, 69
peregrinus, Falco, 28
Perisoreus canadensis, 64
Perognathus baileyi baileyi, 262
    obscurus, 262
    penicillatus pricei, 262

Peromyscus boylii pinalis, 265
        rowleyi, 265
    leucopus rufinus, 263
    maniculatus rufinus, 244, 263, 270
    sonoriensis rufinus, 263
Perrott, Dr. G. St. J., 280
perspicillata, Melanitta, 24
petersoni, Mytonolagus, 362, 400, 402
Peterson, O. A., 373
Phaeopus borealis, 37
    hudsonicus, 36
Phalaropus fulicarius, 49
philadelphia, Larus, 55
Picoides tridactylus, 63
pictus, Calcarius, 80
pinalis, Peromyscus boylii, 265
Pinal Peak, 242
pinetorum, Ribes, 249
pingreensis, Gerris, 194, 232
Pinicola enucleator, 73
Pinus arizonica, 249
    cembroides, 248
    chihuahuana, 248
    strobiformis, 249
Pisobia bairdi, 42
    fuscicollis, 41
    melanotos, 40
    minutilla, 42
Planulina bradii, 333
    elegans, 334
Platanus wrightii, 247
platyrhynchos, Anas, 17
Plectrophenax nivalis, 81
Pluvialis dominica, 34
podiceps, Podilymbus, 13
Podilymbus podiceps, 13
polycanthos, Echinocereus, 249
pomarinus, Stercorarius, 50
Populus tremuloides, 249
Porzana carolina, 32
Potamobates, Key to, 224
Potamobates bidentatus, 227, 240
    horvathi, 226, 240
    osborni, 225, 238
    tridentatus, 228, 240
    unidentatus, 227
Potamobates williamsi, 228
praecinctus, Eponides, 314
Price Pocket Mouse, 262
Prickly Pear, 246
primus, Hyracodon, 361, 388
    Mesagriochœrus, 361, 377
profugus, Limnogonus, 209
Prosopis velutina, 246
Protadjidaumo typus, 362, 394
Protictops alticuspidens, 361, 374
Prunus virens, 249
Pseudotsuga mucronata, 249
pseudoungerianus, Cibicides, 335
Pteris aquilina, 249
pulchra, Buliminella, 305
Pulleniatina obliquiloculata, 332
pungens, Arctostaphylos, 247, 248
pusilla, Wilsonia, 71
pusillus, Ereunetes, 46

quadrilineatus, Tenagogonus, 216, 236
Quercus arizonica, 248
    emoryi, 248
    oblongifolia, 248
    reticulata, 248
    submollis, 249
Querquedula discors, 20
querula, Zonotrichia, 77
Quinlan Mountains, 242
Quinqueloculina auberiana, 295
    seminula, 292
    subquadrata, 297
Quiscalus quiscula, 73
quiscula, Quiscalus, 73

Rammé, Dr. W., 181
recens, Limnogonus, 207, 238
recurvus, Limnogonus, 210, 236
Red-berry, 248
regulus, Cylindrostethus, 222, 238
Regulus satrapa, 67
remigis, Gerris, 189, 234
reticulata, Celtis, 246
    Quercus, 248
Rhamnus crocea, 248
Rhus trilobata, 248

Ribes pinetorum, 249
ribripes, Anas, 17
risseri, Cibicides, 335
Robulus lenticularis, 302
Rocky Mountain Shrew, 251
Rodents, New Duchesne River, and a Preliminary Survey of the Adjidaumidæ, 391-398
rossi, Chen, 14
rothrockii, Bouteloua, 247
rotulata, Lenticulina, 297
Rowley White-footed Mouse, 265
rufinus, Peromyscus leucopus, 263
    maniculatus, 244, 263, 270
    sonoriensis, 263
rupestris, Juglans, 249
    Lagopus, 31
rusticolus, Falco, 28

sabini, Xema, 56
Sahuarro, 246
Salix exigua, 249
    wrightii, 247
Sambucus mexicana, 247
sandwichensis, Passerculus, 75
Santa Catalina Mountain Wood Rat, 265
Sapindus saponaria, 247
saponaria, Sapindus, 247
sarothroides, Baccharis, 246
satrapa, Regulus, 67
schottii, Agave, 247
Sciurus arizonensis, 270
    arizonensis, 244, 260
    catalinæ, 260
    huachuca, 260
Scombramphodon, 283
Scott, Prof. W. B., 357
Seiurus noveboracensis, 70
Selvig, Dr. W. A., 280
seminula, Quinqueloculina, 292
semipalmatus, Catoptrophorus, 39
    Charadrius, 33
serrator, Mergus, 25
Shreve, Dr. Forest, 241
Silk Tassel, 248
Simmondsia californica, 246
Sinclair, Professor W. J., 400
Siphogenerina transversa, 308
Siphonina antioguiensis, 316
    chocoiensis, 317
Sitta canadensis, 66
    carolinensis, 66
Skunk, Arizona, 252
soldanii, Gyroidina, 311
Soldier Camp, 242
    Canyon, 242
Solidago bigelovii, 249
solitaria, Tringa, 38
Somateria mollissima, 23
    spectabilis, 24
Sonoran Desert, 242
    Peccary, 269
sonoriense, Tayassu angulatum, 269
Sorex vagrans monticola, 251
Sotol, 247
sparverius, Falco, 29
Spatula clypeata, 20
spectabilis, Somateria, 24
    spectabilis, Dipodomys, 262
Spermites fragilis, 341
Spermophilus neglectus, 255
Spilogale gracilis gracilis, 252
spinoletta, Anthus, 68
Spizella arborea, 78
splendens, Fouquieria, 246
Squatarola squatarola, 34
squatarola, Squatarola, 34
Squaw Bush, 248
stellata, Gavia, 12
Stephens Wood Rat, 266
Stercorarius longicaudus, 52
    parasiticus, 51
    pomarinus, 50
Sterna paradisaea, 56
Stratton Mine, 243
streperus, Chaulelasmus, 18
striata, Dendroica, 70
strobiformis, Pinus, 249
Sturnella neglecta, 72
submollis, Quercus, 249
subquadrata, Quinqueloculina, 297

subruficollis, Tryngites, 47
summatis, Gerris, 201
Surnia ulula, 61
Sutton, G. M. and P. A. Taverner: Birds of Churchill, Manitoba, 1-83
Sycamore, 247
Sylvilagus audubonii arizonæ, 269
Symphoricarpos oreophilus, 249
Systematic Study of a Collection of Mammals from southern Arizona. By J. Kenneth Doutt, 241-274.

Tamias dorsalis, 259
Taverner, P. A. and G. M. Sutton: Birds of Churchill, Manitoba, 1-83
Tawny White-footed Mouse, 263
Taxidea taxus berlandieri, 253
taxus berlandieri, Taxidea, 253
Tayassu angulatum sonoriense, 269
teliotis, Lasiurus borealis, 251
    Nycteris borealis, 251
Tenagogonus, Key to, 216
Tenagogonus celocis, 218, 236
    opacus, 217, 236
    quadrilineatus, 216, 236
tereticaudus, Citellus tereticaudus, 255
Tertiary Formations of the Uinta Basin, Utah. By J. LeRoy Kay, 357-371
Thomomys fulvus catalinæ, 261
    intermedius, 261
Titanomys visenoviensis, 402
Tolmachoff, I. P., 275
torreyana, Parkinsonia, 246
Totanus flavipes, 40
    melanoleucus, 39
toumeyi, Fraxinus, 247
transversa, Siphogenerina, 308
Travis, Mrs. B. V., 181
tremuloides, Populus, 249
tricamerata, Globigerina, 324
trichas, Geothlypis, 71
tridactylus, Picoides, 63
tridentata, Larrea, 246
tridentatus, Potamobates, 228, 240
trilobata, Rhus, 248
trilocularis, Globigerina, 326
Tringa solitaria, 38
Trochus, 285
Tryngites subruficollis, 47
Tucson, 241
Turbo, 284
Turdus migratorius, 66
turgidus, Palœolagus, 403
typus, Protadjidaumo, 362, 394

uhleri, Gerris, 186, 234
ulula, Surnia, 61
Umbrella Plant, 247
unidentatus, Potamobates, 227
Uria aalge, 58
    lomvia, 58

vagrans monticola, Sorex, 251
varius, Sphyrapicus, 62
Vauquelinia californica, 247
Vegetation (Arizona), 244
velutina, Prosopis, 246
Vermivora celata, 69
    peregrina, 69
Verneuilina fusiformis, 291
villosus, Dryobates, 62
virens, Prunus, 249
virescens, Muhlenbergia, 249
virginianus, Bubo, 59
visendus, Limnogonus, 215
visenoviensis, Titanomys, 402
vociferus, Oxyechus, 33
Vulpes macrotis neomexicana, 269

Walnut, 243
Western Red Bat, 251
wheeleri, Dasylirion, 247
White-throated Wood Rat, 265
williamsi, Potamobates, 228
Willow, Desert, 247
Wilsonia pusilla, 71
wislizeni, Dales, 247
Witter, R. V., 400

Wood, Albert, 400
Wood, Dr. H. E., II, 400
Wright, Dr. A. H., 88
wrightii, Eriogonum, 247
  Garrya, 248
  Houstonia, 249
  Platanus, 247
  Salix, 247

Xema sabini, 56

Yucca, 249
Yucca macrocarpa, 247, 248

Zenaidura macroura, 59
Zonotrichia albicollis, 79
  leucophrys, 77
  querula, 77

CONTENTS

I. **The Birds of Churchill, Manitoba.** By Percy A. Taverner and George Miksch Sutton 1–83

II. **The Life History of the Rufescent Woodchuck,** Marmota Monax Rufescens Howell. By W. J. Hamilton, Jr. 85–178

III. **The Gerrinæ of the Western Hemisphere** (Hemiptera). By C. J. Drake and H. M. Harris . . . 179–240

IV. **A Systematic Study of a Collection of Mammals from Southern Arizona.** By J. Kenneth Doutt . 241–274

V. **A Miocene Microfauna and Flora from the Atrato River, Colombia, South America.** By I. P. Tolmachoff 275–356

VI. **The Tertiary Formations of the Uinta Basin, Utah.** By J. LeRoy Kay 357–371

VII. **List of Species and Description of New Material from the Duchesne River Oligocene, Uinta Basin, Utah.** By O. A. Peterson 373–389

VIII. **New Duchesne River Rodents and a Preliminary Survey of the Adjidaumidæ.** By J. J. Burke . . 391–398

IX. **Mytonolagus, a New Leporine Genus from the Uinta Eocene Series in Utah.** By J. J. Burke 399–420

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